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Meetings

American Chemical Society, Twelfth Mid-West Regional Meeting — May 3, 4 and 5, Kansas City, Missouri.

•

Natural Gasoline Association of America—May 9, 10 and 11, Tulsa, Oklahoma.

•

International Petroleum Exposition—May 12 to 19, inclusive, Tulsa, Oklahoma.

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American Society of Mechanical Engineers, National Petroleum Division—May 14, 15 and 16, Tulsa, Oklahoma.

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American Petroleum Institute, Mid-Year Meeting — May 22, 23 and 24, Wm. Penn Hotel, Pittsburgh, Pennsylvania.

•

American Petroleum Institute, Fifteenth Annual Meeting — November 12, 13, 14 and 15, Dallas, Texas.

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The Course of Oil

By K. C. SCLATER

A.P.I. Spring Meetings Glancing over the programs of the spring meetings of the California, the Southwestern and the Eastern Districts of the A.P.I. Division of Production, one is struck by the variety and scope of the papers presented. The large attendance and the keen interest displayed in the subjects discussed at these meetings are mute evidence of their value as a forum for the discussion by field men of their common problems.

Although the practical aspects of problems met with in a field are stressed, one can observe a growing tendency to increase the scope of the papers so as to include more of the economic aspects of field problems and practices and their effect on other branches of the industry. As a result, field men are beginning to take a broader view of their operating problems and to think of their solution in more comprehensive terms than ever before. Each district usually has certain problems to which it gives more than ordinary attention. By interchanging experiences in combating and overcoming field difficulties such as these meetings provide, field men have a valuable means of obtaining and making contacts that will assist them in their daily work.

Since the purpose of these meetings is to foster the adoption of good field practices, the benefits derived redound not only to the man himself but also to his company and to the entire industry. So long, therefore, as interest is manifest in these meetings and they are participated in by both the officials and the rank and file of the industry, they are an effective medium for promoting progress in production practice.

Improvement in East Texas Vigorous action has recently been taken by the State authorities to stop the flow of hot oil in East Texas. Spurred on by a resolution made at a meeting in Dallas at the end of March of operators and those interested in the welfare of East Texas, the Railroad Commission has made an important shift in its personnel. R. D. Parker, head of the oil and gas division of the Railroad Commission, has been placed in charge in the East Texas field with full authority to take whatever steps are necessary to see that the Commission's regulations are being complied with. Public opinion has been aroused and every effort is being made to uncover the illegal production practices in the field. These practices have been going on for so long and have been so cleverly covered up that the matter of stamping them out will not be easy and one that may take a little time; but progress is being made and Mr. Parker will live up to the trust imposed in him if he succeeds in putting a stop to them within the next two or three months. Latest reports from the field are that a definite improvement is already apparent. Operators, by lending Mr. Parker and his men their full support, can hasten the end of the "hot-oil racket" in East Texas.

Regulating Refinery Runs Despite the fact that crude production has been held reasonably close to the country's needs during the last few months, excessive stocks of gasoline have accumulated. It was thought that by regulating the raw product from which most of the gasoline is made that the accumulation of excess petroleum products could be avoided. Large stocks of crude in storage above-ground have had to be reckoned with; their availability to the refiner apparently has vitiated much of the good results obtained by crude curtailment at the well. It will avail little to curtail crude production if stocks of refinery products are built up far in excess of consumptive needs such as has been done in the case of gasoline. Obviously, a satisfactory solution is the regulation and control of refinery runs.

Hot oil in East Texas, of course, has contributed to this condition, which now has reached a dangerous point. A break in price structure threatens. Adoption of the refinery regulation and control plan submitted to the industry by the petroleum administration will avert it. Overproduction of refinery products and its many evils would be eliminated. Strict regulation of refinery runs will bring good to the greatest number and cannot do harm to even the smallest independent. Without refinery regulation the beneficial effects of crude production curtailment will be of small avail.

Wanton Gas Waste Wanton waste of gas is rampant in the Panhandle field of Texas. The Railroad Commission has admitted its inability to do anything about it. Attention has been focused on the conditions existing there by facts brought out at a hearing of a State Senate investigating committee.

Many stripper plants, the sole purpose of which is to strip the gas of its gasoline content, are in operation in that area. Most of the gas used in these plants is blown into the atmosphere without any attempt being made to return the residue to the formation or to put it to some use. This area is drawn on to supply domestic gas for surrounding towns in Central, North and Central West Texas. Apparently value is placed on the small amount of casinghead gasoline obtained from the gas, but the value of the gas itself is disregarded by most of these stripper plant operators. It is a flagrant waste of gas that should not be tolerated.

Depth and Development Depth is no great barrier to the search for oil. One well in California is now drilling at a depth of close to 11,000 feet. By the time this appears in print a depth of 11,000 ft. may have been exceeded, thus establishing another record. This well is in the Belridge field. If brought in as a producer, it will mean much to future development prospects in the State of California. Each increase in depth attained opens up further possibilities for the discovery of oil.

« « « HIGHLIGHTS IN OILDOM » » »

Gasoline Plan Submitted by Federal Board

The Federal Petroleum Administrative Board has submitted to the industry a plan which has for its purpose the stabilization of refining operations and the balancing of gasoline supply with demand. Secretary Ickes, Oil Administrator, announced the new proposal but made it clear that he had neither approved nor disapproved it, indicating, however, that should a majority of the industry's leaders accept its provisions, he would give his approval and the measure would become a substitute for the section of the oil code dealing with refining.

The proposal, in substance, is a compromise between a refinery quota system urged by the planning and coördinating committee representing industry under the oil code and a voluntary curtailment plan offered by the major companies.

The compromise plan proposes that gasoline production and stocks be strictly regulated to keep supply and demand balanced, and vests the industry with control of agencies established to achieve this end, subject to Secretary Icke's approval.

The plan also provides that the proposed gasoline purchase, or so-called pooling agreement for control of distress gasoline, be made a part of the oil code. The pool would operate under a $10,000,000 revolving fund and would be kept under the close scrutiny of the oil administrator. Participants in the pool would agree to keep their own or distress gasoline off the market.

Provision also is made for the establishment of quotas for the shipment of gasoline into the national market from all or any refineries in a district in which there is an excessive supply, or any refinery which fails to operate in conformity to the plan.

●

Decline in Mexican Oil Exports

During 1933 exports of oil from Mexico dropped to the lowest level since 1913, a report of the Oil Department of the Ministry of National Economy shows. The department reports that 22,016,744 bbl. of petroleum and by-products were shipped abroad last year compared with 22,580,162 bbl. in 1932, despite the fact that petroleum production showed a substantial increase over the previous year. The 1933 figure was 34,000,830 bbl. and the year previous 32,805,496 barrels. The decrease in exports was attributed largely to high American import duties on foreign oil. The peak year of Mexican oil exports was attained in 1922, when the total was 180,866,282 barrels.

●

Legality of Oil Tax Questioned

The question now before the Oklahoma Supreme Court as to whether the tax of one-eighth cent a barrel on crude oil produced in the state for support of the proration department is legal, particularly crude produced from Indian leases in Osage County, may await decision for several months. The court has granted application of attorneys for the State Tax Commission to postpone action in the case brought by Barnsdall Refineries, Inc., and 17 other oil companies seeking an order preventing collection of the tax. The stay was asked because a similar case is now on appeal before the United States Supreme Court, the appeal by the Gypsy Oil Company from a Federal Court decision which upheld the validity of the tax.

●

Gas Lift Plants Not Subject to Ad Valorem Tax

Gas lift plants in Oklahoma are not subject to an ad valorem tax, according to a recent decision handed down by Judge Hal Johnson in an Oklahoma County District Court. Judge Johnson ruled that gas lift plants are considered as machinery necessary for the production of oil and, as such, are covered by the gross production tax, consequently are not subject to ad valorem tax assessments. The decision was handed down in the case of the Indian Territory Illuminating Oil Company.

●

Appeal Texas Decisions to Supreme Court

The Federal Oil Administration has filed in the United States Supreme Court an appeal from the recent decision of Federal Judge Randolph Bryant which held unconstitutional that part of the NRA petroleum code applying to intrastate commerce. The government's case will be handled by Nathan R. Margold, solicitor of the Interior Department and chairman of the Petroleum Administrative Board, and Charles Fahy, first assistant solicitor and vice-chairman of the Board, assisted when necessary by attorneys from the Department of Justice.

The case is being watched with great interest by those in many industries, the decision having bearing on some 300 NRA codes.

●

Back Allowable Question Again

The question of making up back allowables in Texas has been reopened. Recently three suits were filed in the District Court at Austin for the purpose of testing the Railroad Commission's authority in refusing to permit back production to be run. Those bringing suit were the Dink Oil Company, A. F. Bullard Oil Company and the West Florida Oil Company, all operating in the East Texas area. The petitioners claim that the Railroad Commission authorized them to close down when oil dropped to 10c per bbl., with the promise that they would be permitted to run the oil later as back allowable. The Commission subsequently denied them that right, they state.

The question of back allowables has been dormant since November 1 of last year, when the Commission indefinitely suspended further back allowable runs. At that time back allowable claims for 9,000,000 bbl. of oil were on file.

See the Industry Under the Microscope

TULSA MAY 9—19

May 9-11—Natural Gas Association of America.

May 12-19—International Petroleum Exposition.

May 14-17—Petroleum Division, American Society of Mechanical Engineers, Annual Meeting.

May 16—Mid-Continent Oil & Gas Association, Annual Meeting.

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LATEST ACTIVITIES IN THE OIL FIELDS

WHAT may prove to be the largest oil strike in Kansas since the Valley Center discovery in 1928 is the D. R. Lauck and Shoreline Petroleum Company No. 1 Jordan in the Schulte area, southwest of Wichita in Sedgwick County. The well blew in March 18, but was shut in until March 29 awaiting tankage and pipe line connections. A test run that day showed it producing an average of 120 bbl. of 44.4 gravity oil per hour for four hours. The hole later bridged over, but was cleaned out and casing set. The well is producing from the Simpson-Wilcox formation at 3652 to 3653 feet.

•

The Associated Developers Company No. 1 Brazelton, four miles north of the James Pool, in Young County, North Texas, has found a lime formation at 3937 feet, previously having encountered oil showings at 2950 and 3550 feet. Oil men believe it may open a large territory for deep drilling, as it is a rank wildcat, three miles from the Jean pool.

•

Development of the Watchorn Oil Company's semi-wildcat, two miles southeast of proven territory, has been responsible for considerable additional drilling activity in Wheeler County, Texas. The well was drilled to 2449 ft. and flowed 30 bbl. an hour for two hours before being shut in. Pay was found in the granite wash formation.

•

The Cayuga pool in Anderson County, Texas, is being regarded as a possible major field. A second producer was brought in April 10, and started flowing at the rate of 150 bbl. an hour. This was the No. 1 Mrs. N. N. Wills, located a mile northeast of the discovery well. The northeast extension was bottomed at 4086 feet.

The Crescent pool of central Logan County, Oklahoma, was given an extension when the Carter Oil Company's No. 1 Herron blew in a gusher. The Wilcox sand was found at 6204 ft. and oil at 6207 ft., the hole being drilled to 6239 feet. Reports stated 535 bbl. of high gravity oil flowed the first hour.

•

A new producing area in Western Kansas has been opened in Rush County, about six miles southwest of the town of Shaffer. In their No. 1 Shuey, the Boyle-Grossman Drilling Company and L. E. Dewey, of Wichita, and C. W. Mitchell, of Ponca City, Okla., have a well flowing 200 bbl. a day naturally. Production is coming from the Simpson dolomite at 3850 to 3871 feet.

•

The Stanolind Oil and Gas Company's and the Amerada Petroleum Corporation's well, No. 1 Hilger, in the southeastern part of Reno County, Kansas, has possibilities of being an important strike. The well is producing 42.2 gravity oil from the Viola lime at 4064 to 4067 feet.

•

The Vickers Petroleum Company, George Hinkle and the Phillips Petroleum Company have brought in a well, No. 1 Cravens, in southeastern Stafford County, Kansas, that may be the forerunner of a sizeable pool. Production is from the Viola lime at 3920 to 3921 feet.

•

A four-mile extension to the old Searight pool in Seminole County, Okla., has been made by the Carter Oil Company and associates. Their No. 1 Jarvis is a new Wilcox sand well at 4588 to 4596 feet. On a swabbing test of five hours the well produced an average of 25 bbl. an hour of 32.8 gravity oil.

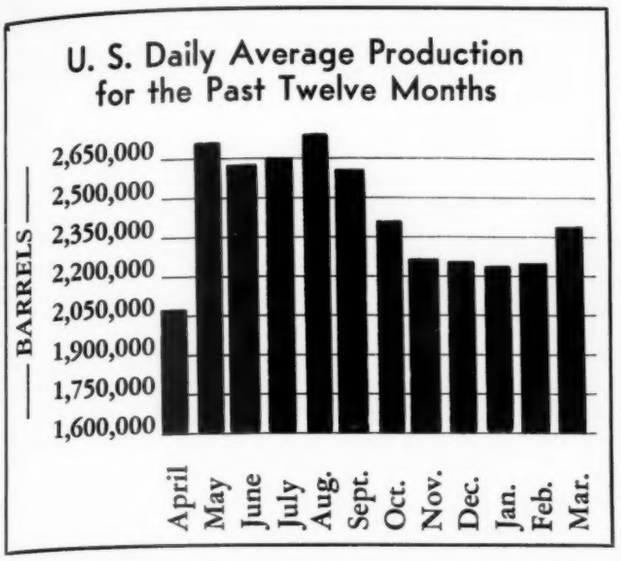
AVERAGE CRUDE OIL PRICES

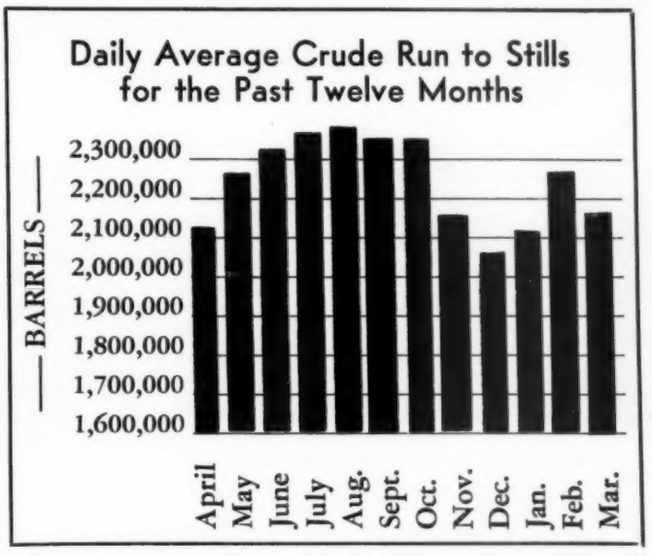
California		Arkansas	$ .70
Playa Del Rey	$ .90	Louisiana	
Coalinga	.81	North Louisiana	.95
Signal Hill	1.12	Gulf Coast	1.04
Montana	1.35	Illinois	1.12
Wyoming	1.00	Kentucky	1.17
Colorado	1.00	Indiana	1.12
New Mexico	.75	Ohio	
Texas		Lima	1.30
North Central	.95	Michigan	1.02
Panhandle	.83	Pennsylvania	
West Texas	.70-.75	Bradford	2.45
Gulf Coast	1.04	Corning	1.20
Darst Creek	.87	West Virginia	2.07
East Texas	1.00	Canada	2.10
Kansas	1.00		
Oklahoma	1.00		

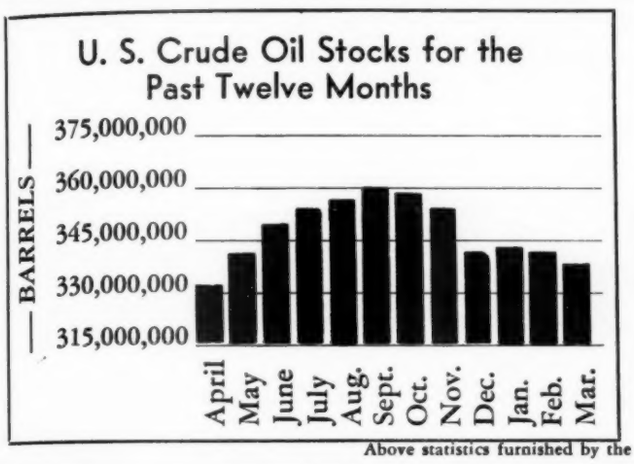
DAILY AVERAGE CRUDE OIL PRODUCTION

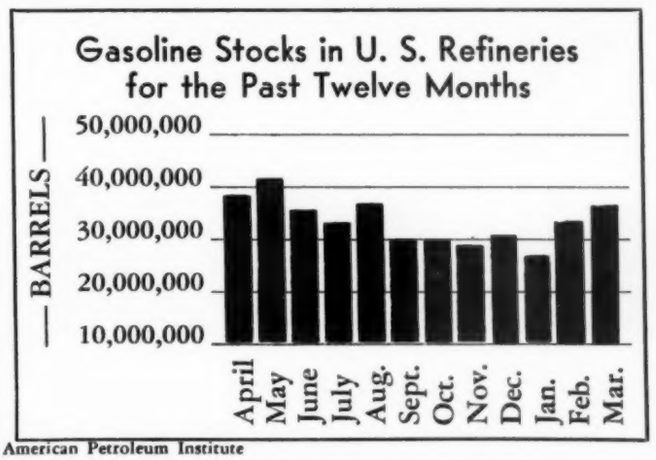
(Figures in Barrels)
Furnished by A.P.I.

	Federal Agency Allowable Effective March 1	W'k Ended March 31 1934	W'k Ended Feb. 24 1934	W'k Ended April 1 1933
Oklahoma	456,400	461,450	440,400	121,100
Kansas	112,300	125,500	109,900	121,100
Panhandle Texas		56,500	52,300	52,550
North Texas		55,900	55,000	52,550
West Central Texas		27,500	26,700	22,750
West Texas		137,600	128,700	162,750
East Central Texas		43,800	43,100	58,150
East Texas		435,450	415,200	398,750
Conroe		48,500	52,900	36,450
Southwest Texas		48,600	43,100	50,050
Coastal Texas (Not incl. Conroe)		111,900	111,750	115,300
TOTAL TEXAS	947,900	965,750	928,750	949,300
North Louisiana		27,600	28,750	30,150
Coastal Louisiana		45,800	44,350	37,650
TOTAL LOUISIANA	71,800	73,400	73,100	67,800
Arkansas	32,200	31,050	31,250	30,600
Eastern (Not incl. Michigan)	95,200	99,650	92,650	93,400
Michigan	29,300	27,200	28,350	13,450
Wyoming	29,600	30,550	30,850	31,450
Montana	7,400	7,100	5,900	5,000
Colorado	2,500	2,850	2,800	2,600
TOTAL ROCKY Mt. STATES	39,500	40,500	39,550	39,050
New Mexico	44,300	42,150	41,600	37,450
California	453,900	458,200	440,500	459,900
TOTAL U S.	2,282,800	2,324,850	2,226,050	2,239,750









Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for March, 1934

Fields	Completions	Producers	Locations	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas									
East Texas	307	303	374	101	358	3600	2	40	Rotary
Duval County	56	52	47	12	61	2300	2	22	Rotary
Refugio County	15	12	15	9	21	5200	2	38	Rotary
Conroe	47	39	15	10	51	3000-7400	3 or 4	40	Rotary
Oklahoma									
Oklahoma City	3	3	4	15	20	6500	3	39	Rotary
Kansas									
McPherson County	18	13	18	8	34	2900-4300	2	38	Rot.-Cab.
Ellsworth Arch	27	21	42	22	60	3300	4	37	Cable
Harvey County	13	12	12	5	15	3450	2 or 4	37	Rot.-Cab.
California									
Kettleman Hills	1	1	4	5	25	8300	3 or 4	40	Rotary
Long Beach	9	8	14	15	48	7000	3	26	Rotary

Field Activities by States for March, 1934

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1933 (In Barrels)
	March	February	March	February	March	February	March	February	March	February	
Arkansas	5	8	2	3	1	2	8	6	31	32	11,682,100
California	28	21	26	21	48	22	45	39	160	146	173,126,800
Colorado	1	4	0	3	....	2	3	3	46	47	954,900
Illinois	1	1	1	0	....	....	1	2	10	9	4,250,000
Indiana	8	16	4	8	....	....	1	2	24	33	730,000
Kansas	92	58	56	42	104	44	44	33	132	125	41,927,700
Kentucky	16	8	11	5	....	....	2	3	39	57	4,610,000
Louisiana	79	49	41	25	64	34	70	50	173	180	24,487,800
Michigan	44	24	33	19	38	20	88	94	120	103	7,790,800
Mississippi	2	2	0	0	2	....	5	2	14	15	Gas Prod.
Montana	10	4	8	4	8	11	6	4	42	47	2,128,700
New Mexico	49	3	49	2	7	....	5	6	21	50	13,086,600
New York	....	....	....	....	....	....	2	3	12	16	3,150,000
Ohio	67	80	50	64	....	....	10	20	75	125	4,300,000
Oklahoma	171	114	116	89	210	107	136	103	391	366	181,133,200
Pennsylvania	12	39	9	35	....	....	28	34	108	114	12,690,000
Texas	842	606	653	469	975	558	256	210	1029	925	396,993,600
West Virginia	55	21	46	18	....	....	14	18	64	72	3,825,000
Wyoming	....	2	....	1	....	....	11	12	61	60	11,211,000
Total	1482	1060	1105	808	1457	787	735	641	2552	2524	898,078,200

PROGRESS OF MAJOR PIPE LINE WORK

THE Stanolind Pipe Line Company, of Tulsa, Okla., has awarded a contract to the Sheehan Pipe Line Construction Company, also of Tulsa, for the laying of approximately 50 miles of 8-in. line on its system between Eldorado and Humboldt, Kansas. The line will be welded Work is to be started soon, it is announced. The capacity of the system will be increased considerably by the added line, which is being installed to handle additional production from Kansas fields, recently made available to the Stanolind Pipe Line Company for transportation to the east.

●

The American-Michigan Pipe Line Company, of Muskegon, Mich., has been granted a permit to lay a 55-mile gas line from Austin Township Pool to Muskegon. The cost is estimated at $500,000.

●

The Pecos Pipe Line Company is taking up its combination 2-, 3- and 4-in. line from the Pecos Valley Pool in Pecos County, West Texas, and will relay it from the same field, but 17 miles north of the present route. The line will connect with the Atlantic Pipe Line Company's carrier from Ward County.

●

A 240-mile gas line will be laid from Central Michigan gas fields to Detroit, Flint and Pontiac if the application for permit of the Industrial Natural Gas Pipe Line Co., of New York City, is granted. James B. Balch, chairman of the Michigan Public Utilities Commission, announces a hearing on the application will be held within a few weeks.

●

The Public Service Corporation of Tennessee plans to launch a pipe line construction program in east Tennessee within the near future, it is announced by J. H. Graham, president. Headquarters of the organization are in Sunbright, Tennessee, and the transportation subsidiary is known as the Sunbright Pipe Line Company. The proposed line will originate in the Sunbright field and will carry gas to various towns in east Tennessee where the company controls franchises. Total length of the line will be approximately 160 miles. The Public Service Corporation of Tennessee is the holding organization for the Rock Creek Oil Company, handling production; the Sunbright Pipe Line Company, the transportation company, and the Harriman Gas Company, the gas distributing subsidiary. Officers, other than Mr. Graham, are Dr. S. H. Jones, vice president, and Mrs. Wilhelmina Andrews, secretary. H. W. Young is field superintendent and T. M. Kingsbury consulting engineer.

●

The Stanolind Pipe Line Company is laying a 6-in. line from the discovery well of the Amerada Petroleum Corporation and the Stanolind Oil and Gas Company in the Langston area, Logan County, Oklahoma, to connect with its 8-in. line running from Cushing to the Orlando area. The distance covered will be 11 miles.

The Cut Bank field of Montana will be the scene of pipe line construction work at an early date. Recently corporation papers were taken out at Helena, Montana, for the International Pipe Line Company, with Yates A. Land, Denver, attorney for The Texas Company, O. M. Webb, Sunburst, another official of the company, and P. Beall, of Cody, Wyoming, as the incorporators. The Texas Company is drilling a number of wells in the Cut Bank field and controls the International refinery at Sunburst, a distance of 26 miles. A line, mostly of 6-in. pipe, will be laid from the Cut Bank field to the refinery. The new company also has purchased the physical assets of the Santa Rita Pipe Line Co., which has 13 miles of 3- and 4-in. line extending from the northern part of the Cut Bank field to loading rack east of Cut Bank.

●

Several companies have obtained charters to build pipe lines in the East Texas field, the majority of which will be either gathering or connecting lines. The companies are as follows: Archer & LaNeve, Inc., Gladewater, Texas; the Marine Export Corporation, Fort Worth, Texas, headed by C. Zethraeus, H. R. Robinson and C. R. Carr; Artex Refining Company, Mac Hall, president, Dick Duncan, vice president and E. C. Holt, secretary and treasurer; and the Control Gathering System, Dallas, Texas.

●

The Kern County, California, Board of Supervisors has granted Robert L. Stockton, Arvin, Calif., a franchise for the construction of a 4-in. natural gas line from the Mountain View oil and gas field to the town of Arvin and surrounding farming district.

●

When a change-over from manufactured to natural gas was made recently at Cedar Rapids and Davenport, Iowa, it was necessary for 40 miles of 10-in. line to be constructed. The new line hooks up near Ainsworth, Iowa, with the Texas to Chicago line of the Natural Gas Pipe Line Company of America. The United Light and Power Engineering and Construction Company, Chicago, Illinois, laid the line.

●

Preliminary work is going forward on a 40-mile 10-in. gas line from the Tioga County field west to the Potter County gas area in Pennsylvania. The Susquehanna Gas Company is the builder of the line and is now obtaining rights-of-way along a route north of and parallel to the Lycoming Producing Company's line between these two fields.

●

An 8-in. gas line to run from Farmington, Pa., to the Potter County, Pennsylvania, gas field is to be built by the Penn Power & Light Company, Williamsport, Pa. The route of the line was surveyed some time ago and approximately two-thirds of the right-of-way has been obtained. The new line will connect with the company's main line that runs from the Farmington field to Williamsport.

THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refining Capacity Operated

Eastern Division, 69.7 Per Cent **Central Division, 62.2 Per Cent** **Western Division, 47.9 Per Cent**

THE Independence Gas Producers, Ltd., will commence construction soon of a gasoline absorption plant in South Turner Valley, Alberta, Canada, according to an announcement made by A. H. Mayland. The plant, which will be erected on the properties of Mercury Oils, Ltd., will have a daily capacity of from 35,000,000 to 60,000,000 cu. feet. Gas supply will be from the Mercury and associated wells principally, but officials state they also will handle production from independents seeking an outlet. Present plans call for operations to begin during the coming summer.

●

The Hercules Gasoline Company recently completed and started operating a gasoline plant west of Kilgore, in the East Texas field. It is located on the Angus Spear lease of the Gulf Production Company. At present the plant has four units; however, four additional units will be installed immediately, bringing the capacity to 10,000,000 cu. ft. of gas per day. One thousand wells are under contract to supply gas. L. J. Dales is superintendent of the plant.

●

The casinghead gasoline plants of the Shamrock Oil and Gas Company, located in the Panhandle field of Texas, will be enlarged, according to plans announced by officials of the company. The plants are the McKee in Moore County and the Clayton in Gray County. Capacity of the McKee plant will be increased from 50,000,000 cu. ft. daily to 120,000,000 cu. ft., and the Clayton plant's output will be stepped up as soon as the necessary gas is available. At present the McKee plant is manufacturing 20,000 gallons of gasoline daily, and the Clayton plant 15,000 gallons. The enlargement program calls for an expenditure of approximately $250,000.

●

Hanlon-Buchanan, Inc., has started construction work on an 8,000,000-cu. ft. natural gasoline plant in Gregg County, East Texas field. Location is on the Bowless lease of the Humble Oil and Refining Company, near the Upshur County line. A gathering system will extend to approximately 900 wells. Pipe will range from 4- to 20-in., with 2- to 8-in. return lines for repressuring. The plant will be completed the latter part of May. C. E. Wharton is supervising construction of the plant and H. J. DeLatin is in charge of the pipe line work.

●

The British American Oil Company is planning to extend materially its refining operations in western Canada. Recently the company acquired the Northwest Stellarene Company's refinery at Coutts, Alberta, which will be operated to its full capacity of 2000 bbl. per day, and announcement is now made that the capacity of the topping plant at Moose Jaw, Saskatchewan, will be increased to 3000 bbl. daily.

●

The Standard Oil Company of New Jersey is constructing a 1000-bbl. phenol treating plant at its Bayonne, New Jersey, refinery, for the manufacture of special grades of lubricating oils. It will be the first phenol-treating plant built in the United States. Two groups of atmospheric and vacuum distillation units will be installed, one for dephenolizing the finished oil and the other for recovering phenol.

●

Toyo Sekiyu Kaisha, a Japanese company, has been granted a license to erect a refinery near Kanagawa. The concern is reported to be affiliated with the North Sakhalin Petroleum Company. The capacity of the plant will be approximately 2,400,000 gal. daily. The company also has acquired a location near Yokohama.

●

Two refineries in the East Texas field have resumed operations following shutdown of several months. The Arp Refining Company (Owl No. 2), at Arp, Texas, and the Johnsonville Refining Company plant at Omega in the north end of the field. The latter refinery was sold recently to Stewart & Eton.

●

The reclamation plant of the E. & F. Refining Company, northwest of Kilgore, Texas, in Gregg County, has been converted into a skimming plant.

●

A 250-bbl. skimming plant is being built at Lubbock, Texas, by the Lubbock Refining Company, using equipment formerly owned by the Humble Oil & Refining Co., at Breckenridge, Texas.

●

The Plainview Refining Company is constructing a 500-bbl. skimming plant at Plainview, Texas, in the Panhandle district. Organizers of the company are J. N. Jordan, J. C. Hooper and Winfield Holbrook.

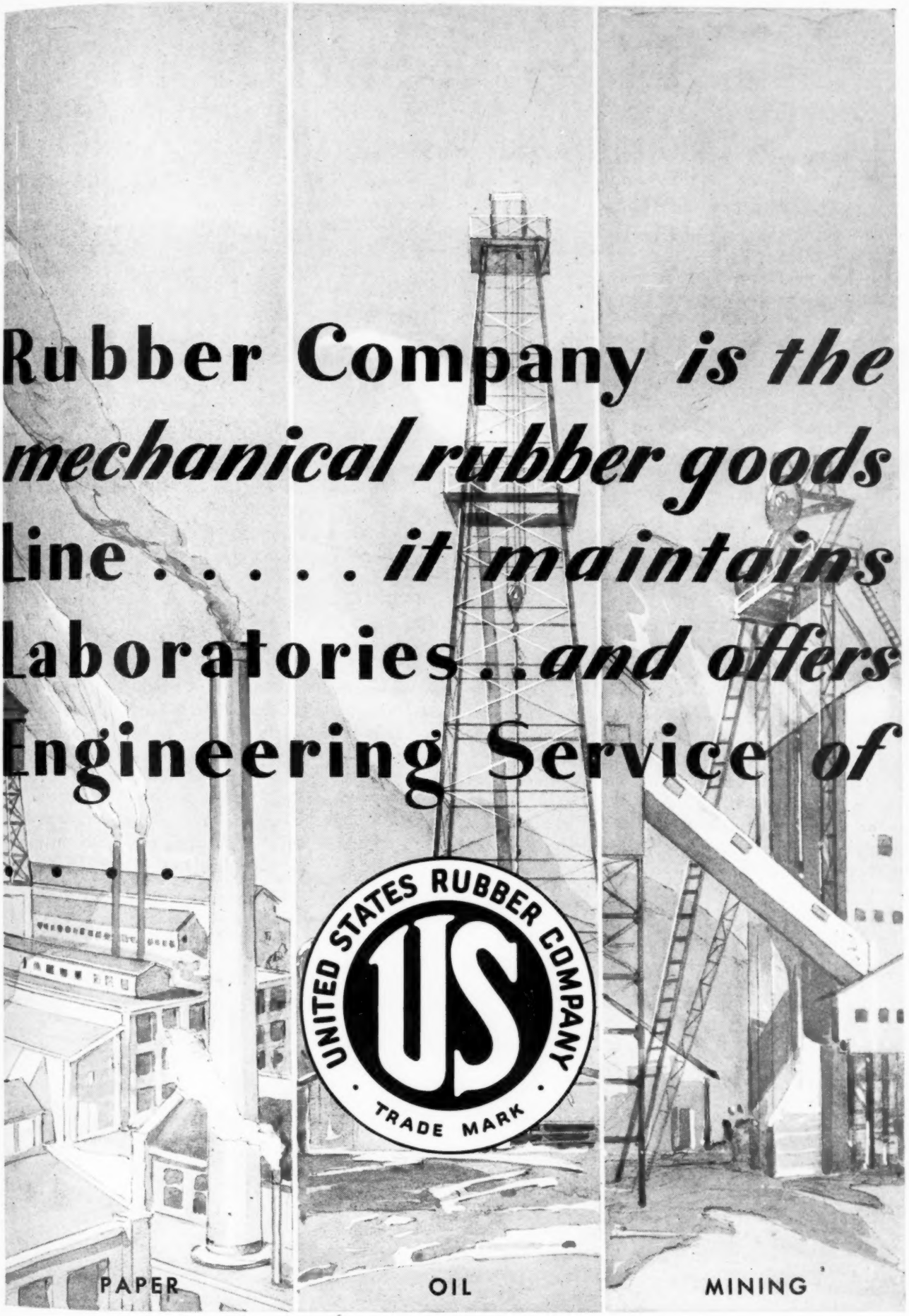
Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending March 31, 1934

A.P.I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	456,000	78.4	17,550	5,279
Appalachian	92.7	88,000	63.3	1,832	714
Ind., Ill., Ky.	94.6	284,000	67.3	9,637	2,828
Okla., Kans., Mo.	83.7	195,000	50.5	5,914	2,739
Inland Texas	47.6	68,000	40.7	1,172	1,697
Texas Gulf	97.4	463,000	87.7	5,418	4,550
Louisiana Gulf	96.4	119,000	73.5	1,683	1,252
No. Louisiana-Ark.	83.7	45,000	58.4	341	584
Rocky Mountain	66.7	34,000	53.1	1,508	676
California	96.9	351,000	42.7	12,043	84,502
TOTALS WEEK:					
March 31, 1934	89.6	2,103,000	62.8	57,098	104,821
March 24, 1934	89.6	2,159,000	64.5	57,011	105,508

The United States
World's Largest Producer of
..makes the Most Complete
the Greatest Research
to industry a Technical
the Broadest Experience.
FOOD
TEXTILE
TRANSPORTATION


Rubber Company *is the*
mechanical rubber goods
Line . . . . . *it maintains*
Laboratories . . *and offers*
Engineering Service *of*
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UNITED STATES RUBBER COMPANY
US
TRADE MARK
PAPER
OIL
MINING

Sand Control in Oi

If Desirable, How Shall It Be Achieved?

IN FIELDS where petroleum is procured from unconsolidated or semi-consolidated sands, the oil producer is confronted with the problem of either inserting screen pipe to restrain the sand or of permitting the sand to flow into the well with the oil. The latter procedure creates new problems in maintenance of well equipment and sand separation and disposal at the surface and necessitates frequent interruption in production for repair and clean-out operations. The use of screen pipe probably results in lower ultimate recovery than might otherwise be obtained in many cases. The operator must determine for the particular conditions presented on his property, which of these two methods of dealing with the sand problem is best. Most American oil producers have resorted to the use of screen pipe where sand is troublesome. On the other hand, in some regions—notably in Russia—screen pipe is almost unknown, it being considered better practice to allow the sand to enter the well with the oil and remove it to the surface. Which is correct? What can be said for and against these two opposing points of view, and is there a possible solution of the sand problem that might be better than either?

Advantages of Screen Pipe. Setting screen pipe opposite the oil sand permits of securing a substantial rate of production free of all but a small amount of fine sand that flows or can be pumped to the surface with the oil. The pumping device, flow tubing and well-head fittings are comparatively uninfluenced by sand-scouring, which can be so destructive when large quantities of sand must be handled. Pumps do not become clogged with sand and accumulation within the well is not a problem of consequence. Well repairs are of less frequent necessity, wells can be kept on production for a greater percentage of the time and maintenance costs are comparatively low. The use of screen pipe tends to keep the oil sand about the well in its original condition, largely preventing any shifting or caving of the formation against or about the screen liner and permitting little or no subsidence of overlying formations which might result in incursion of water into the well or into the oil sand from overlying sources.

If a screen pipe of proper design and size of opening is employed, very little resistance is offered to movement of oil and gas through it. The cross-section of openings in screen pipe available for the passage of oil and gas is usually materially in excess of the cross-section of the pore space of the reservoir sand, so that the rate of flow of fluids through the screen is lower than that through the sand and the screen, therefore, offers comparatively little flow resistance. The width of the screen openings may be as much as 2½ times the diameter of the sand grains without danger of the sand passing through.

Disadvantages of Screen Pipe. While screen pipe of proper type and size of opening offers very little resistance to flow of oil and gas through it, slight readjustment of sand grains immediately about it may, and probably does, result in partial clogging of the screen openings so that flow of fluids into the well is materially reduced. A considerable pressure differential may thus be built up between the inside of the well and the pore spaces within the wall rocks a few inches distant. Release of gas from solution in the oil and gas expansion as a result of this pressure differential, results in cooling of the oil, increase in viscosity and, with some types of oil, separation and local accumulation of solid hydrocarbons. All these effects may result in material resistance to

WHICH IS BEST?

Fig. 1. Well equipped with screen pipe

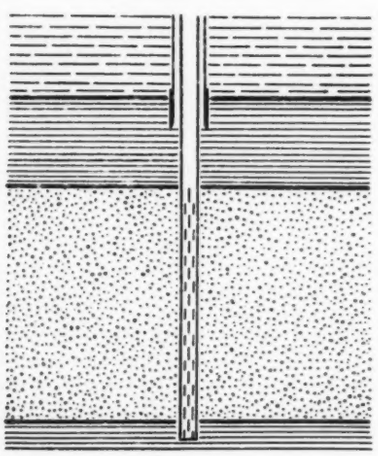


Fig. 2. Well has been allowed to produce sand freely; cavity forms, later partly filled with loose sand; cap-rock caved; liner bent

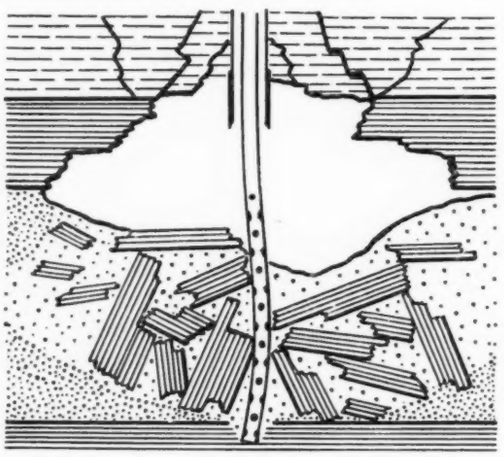
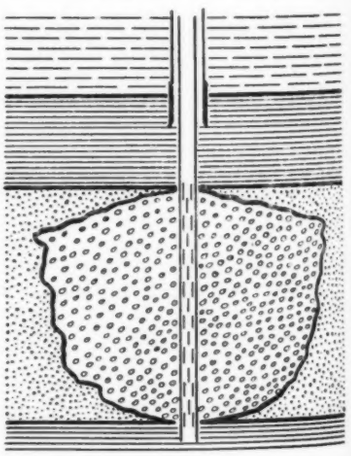


Fig. 3. Well equipped with screen pipe in gravel-filled cavity



Production

By LESTER C. UREN

Professor of Petroleum Engineering
University of California, Berkeley, Calif.

Famous California gusher, Lakeview 1, Sunset field, showing rig and boiler partially buried in sand ejected from the well with the oil. This well was one of the most productive in the district.

flow of oil into the well, thus restricting its rate of production and ultimate recovery. We may be able to offset this tendency in part, by occasional well cleaning and washing of screens and wall rocks with solvents, but such work is costly and often only partially successful in restoring the original permeability of the reservoir rock. Usually unconsolidated sands close in about screen pipe to such an extent that it becomes difficult or impossible to withdraw it in order to afford access to the wall rocks for cleaning or wax removal. Screen pipe is costly and in any comparison wherein a decision is to be reached concerning its use or non-use, the additional cost of well equipment must be balanced against the additional cost of well maintenance when screen pipe is not used.

Difficulties Resulting from Unrestrained Sand Influx. If no screen pipe is used and sand is permitted to flow into the well with the oil, it may seriously impair the well's productivity. Sand accumulating in the well will prevent the oil from having free access to the pump. Wells must be frequently bailed to keep the well cavity free of accumulated sand. Much of the sand will be drawn into the pump with the oil, rapidly destroying valves and seats, scoring the polished surfaces of the plunger and working barrel, thus permitting slippage of oil past the plunger. Sand settling on the plunger and within the working barrel may "freeze" the plunger and valves so that rods and tubing must be withdrawn to the surface.

In the case of unrestrained sand incursion in flowing production in high-pressure territory, the producing formation may "heave" into the wells to such an extent that they suddenly become filled with sand for a depth of many feet and must be redrilled before production can be resumed. Maintenance of sufficient back-pressure at the well head will usually prevent heaving, allowing the oil to lift the sand to the surface as rapidly as it enters the well. In this case, however, sand-scouring of flow-plugs and well-head fittings will often be troublesome, necessitating frequent adjustment or replacement. Unexpected failure of well-head fittings as a result of sand-scouring has in many instances resulted in loss of control of high-pressure wells, usually with disastrous consequences.

Delivery of large quantities of sand with the oil into gas traps and flow tanks occasions no little difficulty in keeping these facilities in proper condition to function satisfactorily. Individual wells have in some instances produced hundreds, or even thousands, of tons of sand, the handling and disposal of which often becomes a matter of considerable concern.

Where such great quantities of sand are brought to the surface, it follows that cavities of considerable size are formed about the wells within the reservoir rock. Extensive unsupported cavities of this character may permit of caving of the cap rock, possibly resulting in admission of top water to the oil sand. Sudden caving of the walls of a large cavity against a perforated, unscreened liner, may result in its collapse or it may be so badly bent that a plunger pump cannot be operated satisfactorily within it, nor can it be readily withdrawn for repair. Caving of strata of shale or clay against the liner may partially close the perforations, perhaps greatly restricting flow of oil. Removal of sand strata may permit interstratified clays and shales to cave, thus sealing off the sand members so that their contained fluids may not gain access to the wells.

Advantages Resulting from Production of Sand with the Oil. If influx of sand with the oil can be sufficiently controlled to prevent the more destructive effects described above and the well kept on reasonably continuous production, important advantages may result from the formation of a cavity about the well within the reservoir rock. A well of large diameter produces its oil much more efficiently than one of small diameter. Oil flows with less resistance into the large diameter well and the natural expulsive energy, which is the cause of flow, is more efficiently utilized. As a result, the large diameter well develops drainage influence over a greater area and both the rate of production and ultimate recovery of oil are increased. Stating this another way, if we are content with a normal recovery per acre, such as would be realized by wells of ordinary diameter, we could achieve this same result with a fewer number of large diameter wells. Development costs would thereby be materially reduced.

In the case of a well of normal diameter, it has been demonstrated both theoretically and experimentally that a large part of the pressure loss and energy consumption occurs within a few feet of the wall of the well. Due to release of gas from solution in the oil, with reduction in pressure, the

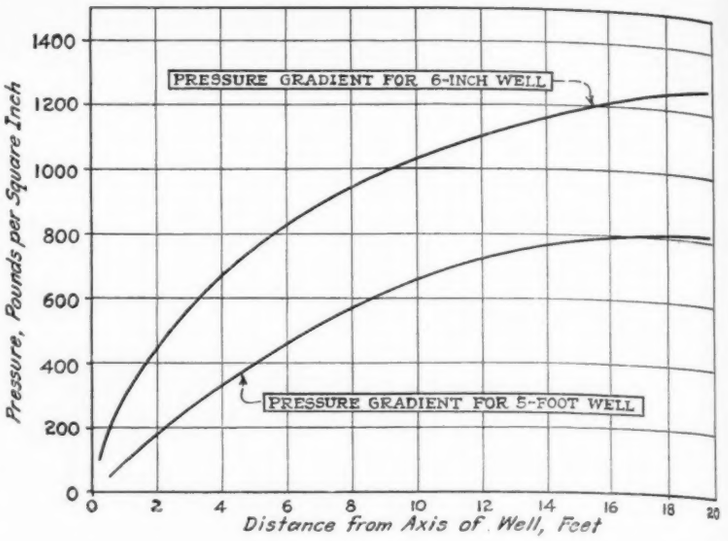


Fig. 5. Pressure gradient within the oil sand about two high-pressure flowing wells, one six inches in diameter and the other five feet

volume of fluid in motion is much greater near the wall of the well than it is farther back in the reservoir rock. Due to the restricted flow cross-section of the reservoir rock near the well, movement of the fluids is much more rapid in the vicinity of the well and since energy consumption is directly proportional to the rate of flow, it is clear that formational gas energy may be conserved by formation of large well cavities, thus removing this zone of high flow resistance.

Our usual method of production through normal diameter wells is comparable with flow of oil through the small end of a funnel. For example, if we are producing oil from a sand ten ft. thick through a 6-in. well and we assume that a drainage influence over a 300-ft. radius is effected, the sand cross-section at the wall of the well through which flow must occur is 15.7 sq. ft., while 300 ft. from the axis of the well, the flow cross-section is 18,850 sq. feet. This may be represented diagrammatically as in Fig. 4. It is clear that if we could cut off, say, five ft., of this drainage cone nearest the apex, as indicated in the sketch, leaving a wall area of 314 sq. ft. on the delivery end of the cone instead of 15.7 sq. ft., we would greatly reduce the flow resistance. This is essentially what results when a cavity ten ft. in diameter is formed or is permitted to form within the reservoir rock about a producing well.

Experimental research conducted in the Petroleum Engineering Laboratories of the University of California with the aid of an apparatus that duplicates all the conditions existing within the reservoir rock in the vicinity of a high-pressure flowing well, confirms the above reasoning. Contrast, for example, the pressure gradients reproduced in Fig. 5, one representing the variation in pressure within the reservoir sand near the wall of a 6-in. well and the other, variation in pressure outward from the wall of a 5-ft. well cavity. The sand was unconsolidated, medium grained, porosity 34 per cent, and the oil a typical California crude of 24 deg. A.P.I. gravity. The same rate of flow was maintained in each case and all other factors influencing drainage were similar. Under a given "field" pressure, 1.5 times as much oil flowed into the well equipped with a 5-ft. cavity as was produced by the 6-in. well. For a given field pressure, the larger diameter well develops a drainage influence over a much greater area than the small well.

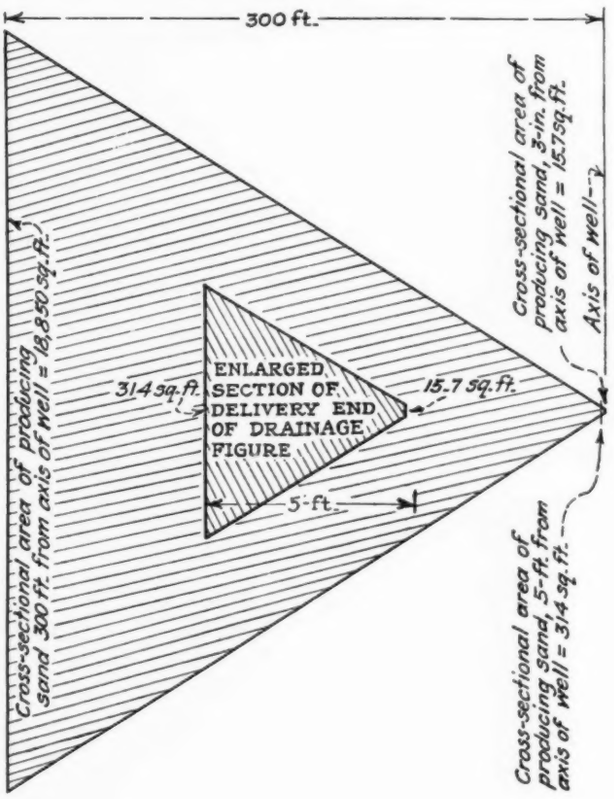

300 ft.
Cross-sectional area of producing sand 300 ft. from axis of well = 18,850 sq. ft.
Cross-sectional area of producing sand, 3-in. from axis of well = 15.7 sq. ft.
Axis of well
314 sq. ft.
ENLARGED SECTION OF DELIVERY END OF DRAINAGE FIGURE
15.7 sq. ft.
5-ft.
Cross-sectional area of producing sand, 5-ft. from axis of well = 314 sq. ft.

Fig. 4. Showing variation in cross-section of the reservoir rock at different distances from the axis of a well. Large triangle represents a drainage area 300 ft. in radius. Small inserted figure is an enlarged view of small end of larger triangle.

Field reports also confirm the conclusion that large diameter wells are more prolific producers than small diameter wells. In fields where oil is produced from unconsolidated or semi-consolidated sands, many observers have noted that where the sand is permitted to flow into the well with the oil, the wells develop a greater rate of production, which is undoubtedly also indicative of a greater ultimate production. The superior production efficiency thus procured is directly due to the formation of a cavity about the well within the reservoir rock.

Mr. W. H. Kobbe, in discussing the production methods used in the Midway-Sunset field of California,[1] observes that wells which produce the most sand are the largest producers of oil. Arnold and Garfias,[2] in discussing conditions in this same area, state that in some cases individual wells have produced as much as 110,000 cu. ft. of sand. This would result

[1]Kobbe, W. H., "Problems Connected with the Recovery of Petroleum from Unconsolidated Sands," Trans., A.I.M.E., Vol. LVI, pp. 799-830 (1916).

[2]Arnold, R., and Garfias, V. R., "Methods of Oil Recovery in California," U. S. Bureau of Mines Technical Paper 70 (1914).

The Lok Batan discovery well, Baku District, Russia. Probably the world's most prolific producing well. An area of several acres about the well is covered with sand brought to the surface with the oil

in the formation of a cavity 56 ft. in diameter about a well in a producing sand 50 ft. thick.

Mr. Paul Munoz, in discussing the recovery of oil from the unconsolidated sands of the Trinidad fields, particularly stresses the importance of admitting sand to the wells with the oil during early life, in order to encourage the formation of drainage cavities. He states that:[3]

"Some of the companies operating in Trinidad allow the well to clean itself by flowing outside of the oil string through flow lines attached to the blow-out preventer. This brings large quantities of sand to the surface along with the oil and the well usually sands up between the oil string and the water string after a few hours' flow. The wash pipe is then pulled and the well brought in through the screen or perforated pipe. Wells brought in by this method are usually large producers if sufficient sand is brought to the surface to make an under-ground cavity into which oil will be drawn from the surrounding territory without bringing more sand along with it; but if the well sands up before thoroughly cleaning itself of sand, it will continue to give sand troubles when brought in through the screen or perforations and will not make a large producer. . . . Wells brought in without permitting sand to flow, are not as large producers as wells which are allowed to clear themselves of sand."

The writer has personally observed results obtained in unconsolidated sand fields in the Baku district of Russia, where the use of screen pipe is unusual and no particular effort is made to restrain influx of sand. Wells often sand up and require frequent cleaning during early life, but eventually settle down to a long period of substantial production with comparatively little sand trouble. Remarkably high per-acre yields are procured, resulting in unusually high percentage recoveries. Probably the most prolific well ever completed—the discovery well in the Lok Batan field, near Baku, Russia—which produced 250,000 tons of oil in 13 days, and at times was estimated to be flowing at the rate of 175,000 bbl. per day, produced enormous quantities of sand with the oil. Mr. A. B. Thompson, the well-known British authority, with many years of experience in the Baku district, in discussing the hydraulic method of forming well cavities, with gravel fill, proposed by the writer in an earlier paper, says:[4]

"The importance of enlarging the diameter of wells to obtain increased yield has always been fully appreciated by hydrologists. . . . In many cases of loose sands, the proposed conditions of gravel fill are naturally reproduced and play an important part in sustaining yields and establishing equilibrium. Most of the violent eruptive wells of Russia and Roumania expel enormous quantities of sand, as well as abundant rock fragments in their initial life, thereby preparing a sump of considerable capacity somewhere below and not distant from the shoe of the casing, but a time is reached when the flows are less violent and only sand is ejected with the oil."

Numerous other instances are recorded in which wells producing large quantities of sand have developed unusually large productions. One of the most productive wells in the Earlsboro district of Oklahoma, is said to have been the Skelly Oil Company's Spencer No. 1, which produced "several car loads" of Wilcox sand.[5] This well produced as much as 13,000 bbl. of oil in 24 hours. The St. Helens Petroleum Company's No. 2 well on Section 26-28-27 of the Kern River field of California, produced large quantities of sand during early life, and developed a rate of production far above the average for the area in which it is situated.[6] In many instances, the larger producing wells in the Oklahoma City field have been large sand producers.

Artificially Formed Gravel-Filled Well Cavities. A possible means of realizing all the advantages of the large diameter well, with none of the difficulties resulting from uncontrolled influx of sand, is that of forming a cavity about the well within the reservoir rock by hydraulic means when the well is drilled, and then filling the cavity so formed with gravel of appropriate size. Pore spaces within the gravel filling are so large as to offer practically no resistance to oil flow, yet they are small enough to restrain further influx of sand from the reservoir rock. The gravel functions both as a screen and as a support for the walls of the artificially-formed cavity. The writer has proposed what he believes to be a practical means of forming such a cavity and filling it with gravel.[4] The method has been successfully demonstrated in providing gravel envelopes about deep water wells. The general result to be sought by such work is pictured in Fig. 3.

A gravel-filled cavity of this character would not add greatly to the initial cost of the well and yet would greatly increase its rate of production and ultimate recovery. For productions comparable with what we obtain by present methods of development, we might achieve the same result with half as many wells equipped with gravel-filled cavities. The writer has estimated that under certain common conditions, a saving of 35 per cent or more in unit production cost might be realized by this practice.

[3]Munoz, P., "New Oil Fields in Trinidad," Mining and Metallurgy (A.I.M.&M.E.), July, 1927, pp. 311-314.
[4]Uren, L. C., "Increasing Production of Petroleum by Increasing Diameter of Wells," Trans., A.I.M. & M.E., Vol. LXXI, pp. 1276-1300 (1925), with discussion by A. B. Thompson.
[5]See *National Petroleum News*, issue of August 17, 1927, p. 28.
[6]See *Oil Weekly*, issue of December 23, 1927, p. 36.

Avoiding Operating Troubles in

By SAM MONROE
District Machinist
Stanolind Pipe Line Company

THREE-STAGE compressors, commonly used for air injection Diesel engines, are usually of the steeple or differential piston type. Because of the necessity for compactness in this service, they are not always so liberally designed as a commercial type compressor of the same capacity, particularly with respect to the water cooling of the cylinders and intercoolers.

There are several methods of regulating the supply of compressed air. As the demand of injection air used in a Diesel engine varies with the operating conditions, some method of increasing or decreasing the output of the compressors must be provided to supply the correct amount of injection air to meet load requirements. On Diesel engine compressors the methods commonly used for regulating the air supply are among the least desirable methods available, that of throttling the compressor to the desired capacity on the intake of the first stage. Problems confront the engine manufacturer that force him to use this method of regulation on account of its simplicity. A more desirable method of regulation, if adopted, however, probably would result in complications and conditions of operation that would be detrimental to engine service. Throttling the intake supply greatly increases the total ratio of compression, depending upon how much throttling is done, and higher discharge temperatures per compressor stage are the immediate result. The increase in ratio of compression, augmented by leakage and other factors, contribute further to higher discharge temperatures.

Throttling the low-pressure air supply has certain effects that may be studied by referring to Fig. 1, which represents the hypothetical cycles most nearly approaching this case. In order to reduce from full load low-pressure capacity—that is, from AB to AE—the supply pressure is decreased by throttling to pressure B′, such that B′ and E lie on the same adiabatic. The work area A′ B′ E A is entirely used up in overcoming throttle resistance and is useless friction, so that economy is seriously reduced by this method of regulation. Such compressors use almost as much power at partial as at full capacity. From this illustration it is easily seen that the only advantage of this method of regulation is its simplicity.

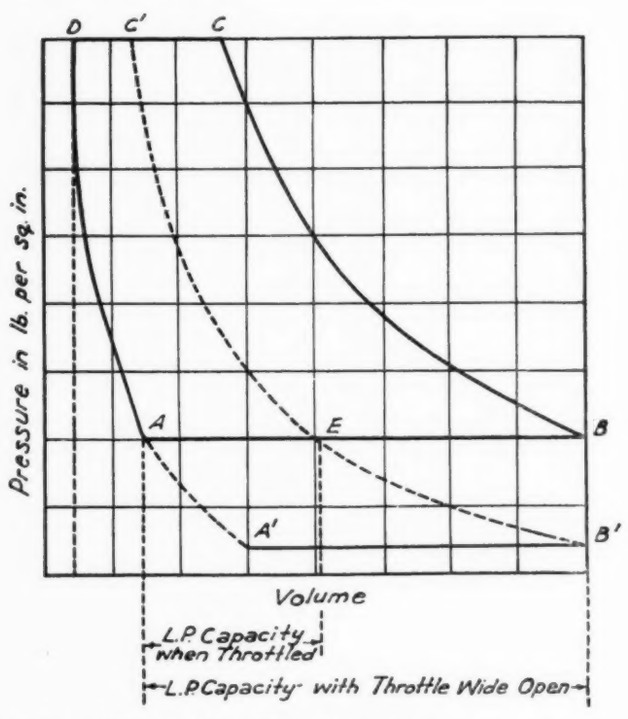


Fig. 1. Effect of throttling the suction of a one-stage compressor, on capacity and economy *(after Lucke)*

Since this method of regulation is necessary, it is important that added precaution should be taken to see that the cooling water in the cylinder jackets and intercoolers counteracts the increase in temperature that results when this method of regulating the injection air supply is used.

When the principles of operation are understood and the necessary safeguards taken by the operating personnel, compressor explosions or failures of any kind caused from overheating or overloading in any one of the three stages in a compressor will become a rare thing.

Compression of air by stages is a means of limiting the temperature range per cylinder. To divide the work equally among a given number of stages, the ratio of compression in each stage is found by taking the total ratio of compression, and extracting the root corresponding to the number of stages selected. For example, for 800-lb. discharge pressure at sea level, the total ratio of compression is 55.4. If three stages were selected, the ratio per stage would be the cube root of 55.4, or 3.81. This is a satisfactory compression ratio per stage in a compressor. Assuming an atmospheric temperature of 70 deg. fahr., the theoretical temperature per stage of compression would be 320 deg. fahr., and with good circulation in the water jacket an actual discharge temperature of approximately 280 deg. fahr. should be obtained. A set of three-stage compressor curves is shown in Fig. 2.

A simple way to check the balance per stage is as follows: if the discharge pressure of the first stage is 50 lb. and the compressor is running with the throttle wide open, 14.7 (the atmospheric pressure at sea level) divided into 50 (the discharge pressure) equals 3.59; if the discharge pressure of the intermediate stage is 200 lb., 50 (the intake pressure) divided into 200 (the discharge pressure) equals 4; if the discharge pressure of the high stage is 800 lb., 200 (the intake pressure) divided into 800 (the discharge pressure) equals 4. This indicates a good average balance on a three-stage compressor.

If the compression ratio—that is, the intake pressure divided by the discharge pressure — were 4.5 or 5, it would indicate a dangerous operating condition and the compressor should be inspected for leaky valves, leaky rings, faulty cooling (due to scale or mud), or any other likely cause contributing to unbalanced stages of compression. Compressor authorities agree that any operating condition causing the temperature to go beyond 400 deg. fahr. will sooner or later lead to serious trouble.

If any of the fundamental principles of compressor operation are neglected, the cumulative defects that rapidly develop are likely to deceive the operating engineer and cause difficulty in tracing the exact source of the trouble. The operating engineer cannot afford to neglect the principles governing temperature and pressure control, which is accomplished through correct cooling, checking for leaky valves and rings, keeping the water passages clear of mud

Air Injection Compressors of Diesel Engines

and scale and feeding a liberal supply of cool water through the water jackets.

Exercise good judgment in the amount the intake air is throttled. This can be done by increasing or decreasing the clearance between the head and piston to bring the compressor within a reasonable range of the service demands and suitable to the particular operating condition.

Operating engineers should keep in mind that certain practices followed in operating commercially designed compressors must be modified when applied to the operation of Diesel engine compressors. Consider, for example, the important factors that affect compressor operation as applied to commercially operated compressors and compressors operating as a part of a Diesel unit. The commercial compressor can be designed as a separate unit and the best known methods of air supply control and cooling of cylinders and intercoolers adopted and liberally provided for. Everything may be incorporated in the design that will contribute most to the efficiency of the compressor. On this type of compressor it is considered the best practice to maintain the smallest amount of clearance possible between the piston and cylinder head; and only when this is done can the compressor be made to perform at the highest efficiency.

On the compressor supplying air for a Diesel engine the designer is almost compelled to use a method of regulating air supply that is the least desirable known, one factor that more than any other results in throwing out of balance the compression ratio per stage. The efficiency gained by operating with the closest possible clearance between piston and cylinder head has to be sacrificed in order to maintain the correct balance between piston and cylinder head and the amount of work performed per stage and, at the same time, adjust the compressor within a reasonable range of operating demand so as to prevent excessive throttling of the intake air. This is one of many comparisons showing why the methods of handling a compressor must, necessarily, be in keeping with the design and particular service in which the compressor is used.

It has been the writer's experience that lubricating oils are often blamed, unfairly, for compressor explosions and carbon deposits. These will follow, regardless of how good the lubricating oil may be, if wrong methods of operating the compressor are used. Some lubricating oils, no doubt, may lead to trouble quicker than others, but when a compressor is operated at a temperature above the limit recommended for the lubricating oil, explosions and other troubles are sure to develop. If the proper operating conditions are maintained, a compressor requires less lubrication than most machines of similar design. Use lubricating oil sparingly.

Quite often in service work on Diesel engines, the writer is asked to state definitely, what the correct clearance should be between the piston and cylinder head. In some instances, instruction books (giving definite settings) have been supplied the operating personnel. This can be done only when all details of the operating conditions are known. The engineer must take into consideration his own local conditions of operation, for the volume and pressure demands may vary, requiring that the piston clearances be adjusted accordingly. Here are a few adjustments on Diesel engines that are seldom the same in any two plants: lift on the spray valve needle, speed of engine, load conditions, viscosity of fuel, timing on the engine, worn parts, regulating the passage of fuel and injection air through the atomizer and spray nozzle. All these influence the demand of injection air supply, either by pressure or volume.

Compressor conditions can easily be checked by having the engine at the desired operating condition for a test, then opening the throttling device on intake air supply to the limit, and noting the percentage increase of injection air. This will indicate the percentage that the compressor is throttled. If it is throttled more than 30 per cent a wider clearance between the head and piston should be adjusted. If it is less than 20 per cent a closer clearance should be adjusted, provided the condition of the compressor is known to be good.

It is good practice to maintain a compressor on a Diesel engine to operate with a reserve capacity of 20 per cent minimum of engine demand and a 30 per cent maximum of engine demand, to meet different load and other conditions.

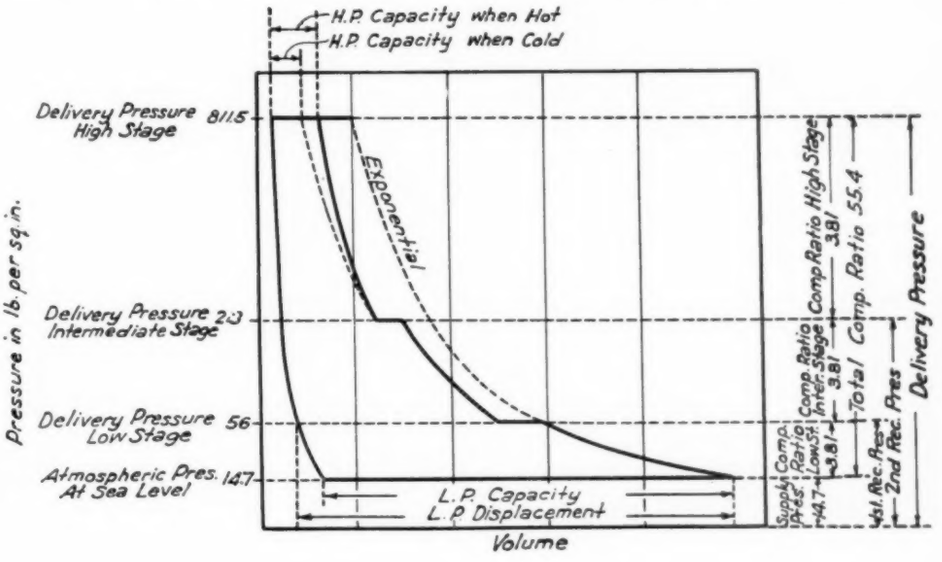


Fig. 2. Three-stage compressor curves assuming perfect intercooling, theoretically perfect compression ratio balance per stage. Re-expansion volumes equal to low-pressure cylinder clearance *(after Lucke)*

Here is shown the cementing of the 9909-ft. string of 6⅝-in. casing in progress

By
K. C.
SCLATER

Below—Left:
Hugh Rapp, Superintendent;

Right: R. G. Rapp, President, Denver Producing and Refining Company

Center: Bill Henson

Casing and C Binger Well a

DISCOVERY of oil and gas in the Denver Producing and Refining Company's prospect well Adak-Noc No. 1 near Binger, Caddo County, Oklahoma, at a depth below 9900 ft. is a development of more than passing interest. Besides having the earmarks of a promising prospect that may open a new, deep, prolific pool, the well has established somewhat of a record in having been cased, cemented and completed to its present depth without serious trouble.

The string of casing set is the longest of its size and weight yet run in a well, and was cemented by the multiple stage process. In a deep well the setting and cementing of the casing are important items contributing to the successful completion and the placing of the well on production.

Drilling of this well was started January 5, 1933 and was continued to a depth of 9540 ft., which depth was reached July 2, 1933. From July 2 to December 22, 1933, the well was shut down. About January 6, drilling was resumed, but due to the drill pipe freezing, drilling was delayed about a month. On March 8, the top of a productive oil and gas sand was struck at 9910 ft. The well was eventually drilled to 9982 ft., and later, when drilling out the cement plug, to about 9986 feet.

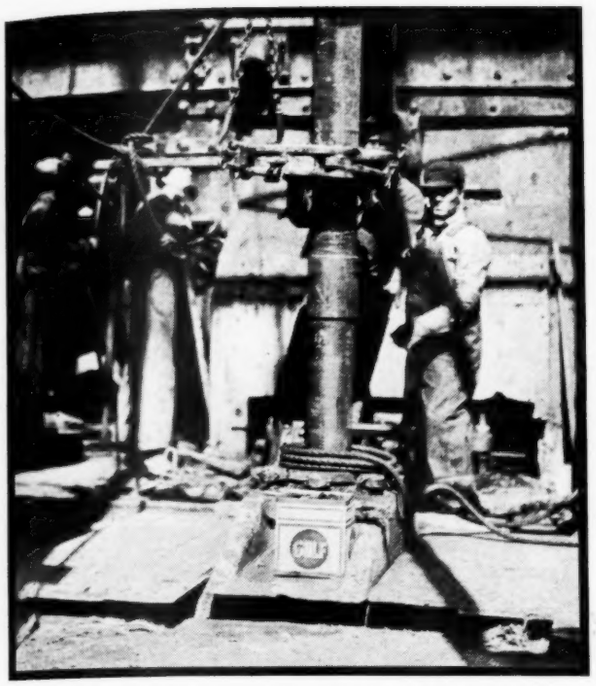
Although some difficult fishing jobs arose, no really serious drilling problems seem to have been encountered. On the whole the formations penetrated are hard and little trouble was experienced from caving.

When oil and gas were struck, caution had to be exercised in order to keep the well under control. Aquagel and Baroid were used to condition the mud and give it the desired weight and consistency. With about 70 ft. of penetration below the first showing of oil and gas at 9910 ft. and the well acting as if it might make a good producer, it was decided to land a string of casing at about 9921 feet.

The hole at this time was cased with about 126 ft. of 15½-in. 70-lb. surface pipe, which was cemented with 175 sacks of cement, and a 6238-ft. string of J. and L. 9-in. O. D. 40-lb. seamless casing set with 2250 sacks of cement. Below the 9-in. a 8⅛-in. hole had been drilled to bottom (9982 ft.).

A string of 6⅝-in. O. D. 26.20-lb. 10-thread special alloy seamless National Tube Company casing with long threads and couplings was run to 9909 feet. The couplings are 9-in. long by 7.390-in. O. D. and of special length. The threads have a taper of ⅜ in. per ft. with a total length of thread of 3.8 in. or 38 threads. Running of the 6⅝-in. casing began Saturday morning, March 10, and was completed by noon Sunday.

At 7300 ft. a tight spot or shelf in the hole caused a delay of four hours. For a time there was serious doubt whether the casing could be lowered any farther. As a last resort, twisting of the traveling block and lines to the left was tried. By letting down the weight of the casing gradually and turning the



Running the
9909-ft. string of casing

Cementing the at 9909 Feet

casing slowly to the right the guide shoe was successfully worked past this bad place in the hole.

In all, 328 joints of casing, each an average length of 30 ft. 6 in. and having a total weight of approximately 132 tons, were run in the well in about 19 hours actual running time.

Every precaution was taken to avoid any failure or delay in running the casing. All threads were cleaned with steam and closely inspected for damaged threads. A high grade zinc dust lubricant was used to protect the threads and to help insure that the joints would make-up properly. The joints, after stabbing, were made up with a spinning rope operated from the cat-head, care being taken to use a speed so regulated that the possibility of galling of the threads would be reduced. Heavy tongs and cat-head power were employed for the final make-up of each joint.

After each 25th joint run in the well the inside of the casing was filled with mud fluid. This practice was discontinued at 8500 ft., however, for fear the delay resulting would lead to freezing of the casing.

Equipment was used on the casing for floating it in consisting of a Halliburton cement guide shoe on bottom, a Halliburton float collar in the first joint and another in the third joint above the guide shoe. Another Halliburton float collar was placed in the casing string in the joint below the Halliburton multiple stage cementing tool at about 7930 ft. or approximately 2000 ft. above the guide shoe.

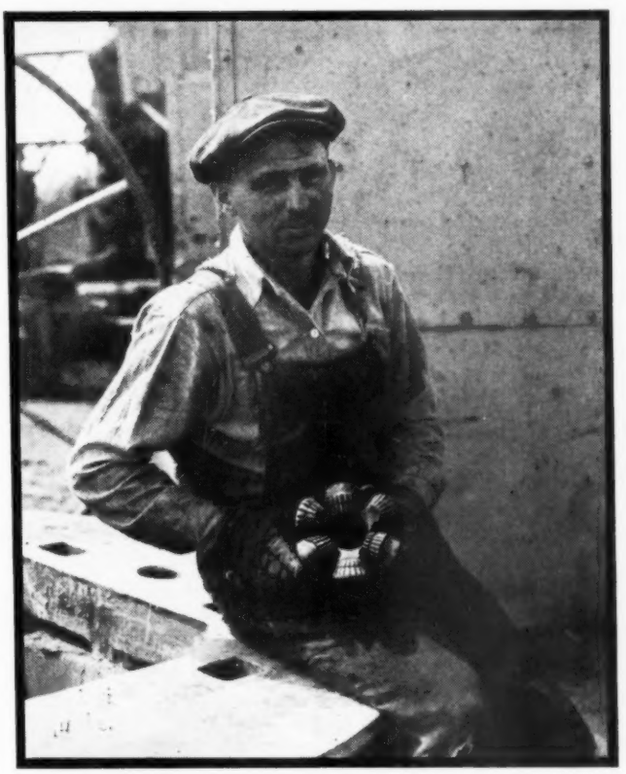
Cementing of the casing was done in two stages, but in one continuous operation, by the Halliburton multiple stage cementing process. Instead of pumping all the cement down the entire length of casing and around the casing shoe, only part of it—usually about half—is pumped around the shoe, the rest of the cement is placed behind the casing through the multiple stage cementing device inserted in the string of casing at a pre-determined point.

When placing cement in large quantities behind long strings of casing, time, temperature and pressure are important items to be taken into consideration. High temperature accelerates the setting of the cement, which, if there is any delay, may necessitate high pump pressure to place all the cement behind the casing. Thus, time is of the essence in a casing cementing job. By placing the cement behind the casing in two stages the pump pressures can be reduced to about half of that required when all the cement is pumped around the shoe. In deep wells, the possibility of damage by high pressure to the lower end of the casing string is also reduced.

The cementing tool or device used in the multiple stage process consists of a long coupling or outside sleeve containing holes or ports. When the casing is being run these ports are covered by an inner sleeve, which is held in position by several small metal pins. A special plug sent down just ahead of the second batch of cement engages the inner sleeve, shears off the pins and pushes the sleeve down so that it uncovers the ports.

This stage device was placed in the tubing string at 7901 ft. or approximately 2000 ft. above the guide shoe.

The well was cemented in two stages with 3000 sacks of cement, 1300 of which were pumped around the shoe and 1700 placed behind the casing through the ports in the stage device. A column of heavy mud 1900 ft. long was pumped in on top of the first batch of cement. Then, on top of the column of mud a special wooden plug was inserted to engage



Hughes rock bit used
to core the well

Hughes rock bits used in drilling the well

the inner sleeve of the stage device. No perceptible pump pressure was observed until the top of the second batch of cement was about 1500 ft. above the cementing tool. The pump pressure was then observed to increase to 500 lb., but did not go any higher. It is to be noted that this pump pressure would have been much greater had not the mud behind the casing become gas-cut.

It took about two hours to place the cement, using one large steam pump and one power pump with a total pumping capacity of about 65 sacks per minute. About 100 ft. of cement was left in the casing above the guide shoe and above the stage device to insure a thorough cement job. These plugs were later drilled out with a Hughes rock bit. On March 21, or 11 days after cementing and after having drilled out the plugs, the casing was hydraulically tested to 6400-lb. pressure as a precaution before starting to bail in the well and also to test the strength of the stage device.

Testing of the casing by vibration showed the upper batch of cement to have filled behind the casing to a height of 4800 ft. from the surface. This left the cement about 1400 ft. inside and above the shoe of the 9-in. casing.

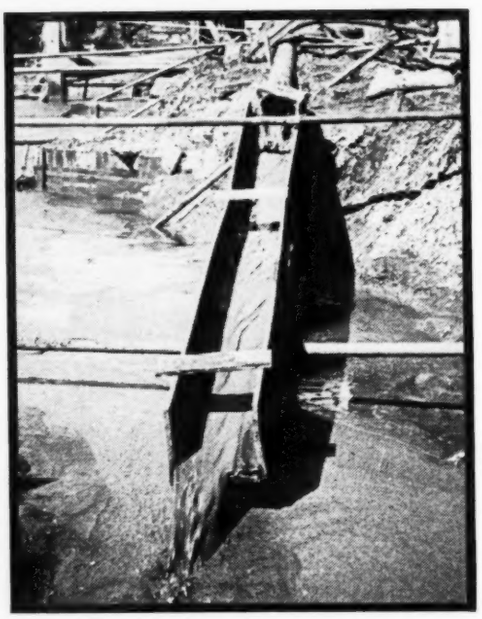
Under ordinary conditions should other wells be drilled on this structure the casing will probably be landed before penetrating the pay sand, in which case there will be no possibility of the drilling fluid behind the casing becoming gas-cut. Greater pressures than required in this well will, therefore, be necessary to place the cement. Then will the real benefits to be derived from the two-stage process of cementing become more apparent.

At present the well is being bailed in an effort to start it flowing. Although 13 ft. of the hole was cored at the present bottom depth, a recovery of only 7 ft. was obtained. The part of the core recovered shows the sand to be tight. It is possible, however, that the core of the most prolific part of the pay was not recovered. The well has made several strong flows for short periods. There is the possibility that the productive part of the sand has been mudded up. Of 150 sacks of Aquagel, 2334 sacks of Baroid, and 150 sacks of Ada mud, in addition to large quantities of drilling mud used in the hole, only a relatively small quantity has been recovered in the returns.

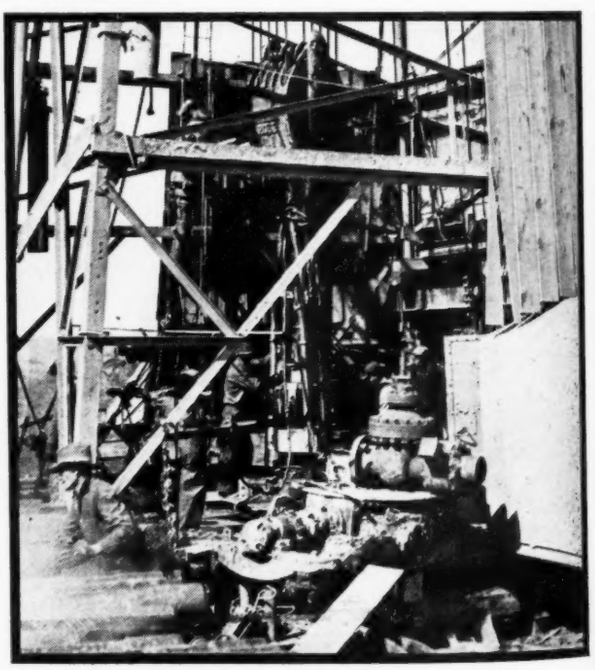
A bridge had formed at a depth of 8200 ft. but this has been removed and the well is now being bailed off bottom and light oil of about 38 gravity A.P.I. rises in the hole through the mud to almost surface level. Work is being carried on only during daylight, and since the bailer has a capacity of about one barrel only and it takes about one-half hour to make a round trip, the process of cleaning out with the bailer is a slow one. It is reported at this writing, however, that the pressure in the well is increasing and the flows becoming more vigorous. Further bailing may remove sufficient of the mud to allow the well to start flowing and clean itself.

There is another possibility. The sand may be so tight that the oil and gas will not flow into the hole at a rate fast enough to maintain flow in the casing for any appreciable length of time. The owners of the well are proceeding cautiously, attempting first to unload the well of heavy mud and give the well every chance to flow. To go ahead and deepen the well at this juncture may not be advisable.

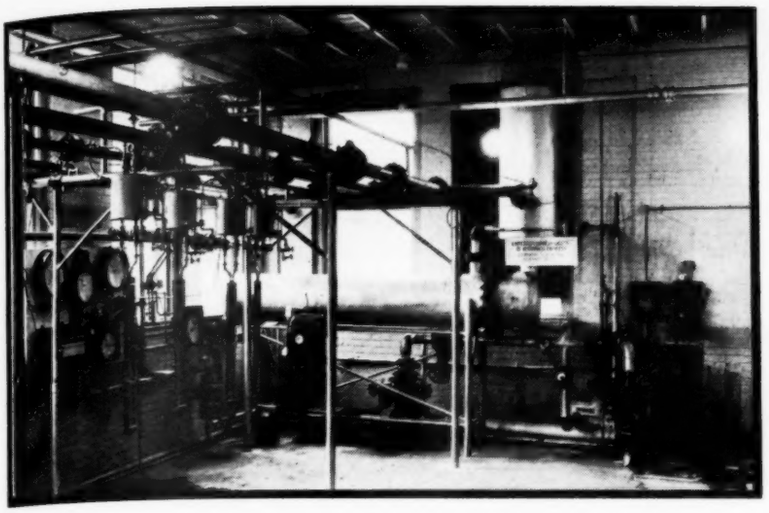
Whatever happens at this well, it is certain that experience gained in casing and cementing at this depth in this area will prove of value in any subsequent well completions. The fact that the well has been completed to its present stage in such good condition is a creditable undertaking.



Another view of well while running casing



Left: Scanty mud returns badly gas-cut even though pumping at full speed



A Section of the Testing Laboratory Showing General Layout of Equipment

Research on Fluid Flow in Pipe Lines

ONE of the most important research projects ever to be conducted, either in this country or abroad, on the measurement of fluid flow in pipe lines has been started at the University of Oklahoma Experimental Engineering Laboratories, under the personal supervision of W. H. Carson, head of the schools of Mechanical and Petroleum Engineering, and sponsored by the Fluid Meters Sub-Committee of the Mid-Continent Section of the American Society of Mechanical Engineers. The works of all research projects on the metering of oils have been reviewed and a wide variation in the meter coefficients has been found to exist. The ultimate object of this project is, therefore, definitely to establish new, or to check existing meter coefficients for use when metering viscous fluids.

This sub-committee has obtained approximately seven thousand dollars worth of equipment necessary for the test set-up, practically all of which has been loaned or donated by various manufacturers.

The committee is composed of the following engineers: Glenn Wynn, Mid-Continent Petroleum Corporation, Chairman; M. L. Cobb, Continental Oil Co.; W. H. Carson, Hugh Corrough, Empire Company; G. B. Lane, Foxboro Company; L. G. Rheinberger, Sinclair-Prairie Company; W. G. Heltzel, Stanolind Pipe Line Company; J. N. Hunter, Gulf Pipe Line Company; A. J. Kerr, Midwest Equitable Meter Company; L. K. Spink, Foxboro Company, Foxboro, Mass.; J. O. Feldmark, Brown Instrument Company, Philadelphia, Pa.; J. C. Diehl, Metric Metal Works, Erie, Pa.; and Harold Adkison, A.S.M.E., who have convened on numerous occasions over a period of two years and with the assistance of R. E. Sprenkle, Bailey Meter Company, Cleveland, Ohio, and L. E. Smith, Builders' Iron Foundry, Providence, R. I., have brought about an agreement among the leading fluid meter engineers of this country on the correct layout of equipment and procedure of the test, to insure the acceptance of the results as authentic by the industry.

The tests at present are being conducted by C.W.A. research workers and special students of the College of Engineering. The C.W.A. personnel working in two daily shifts of six hours each for five days a week and the students working the sixth day.

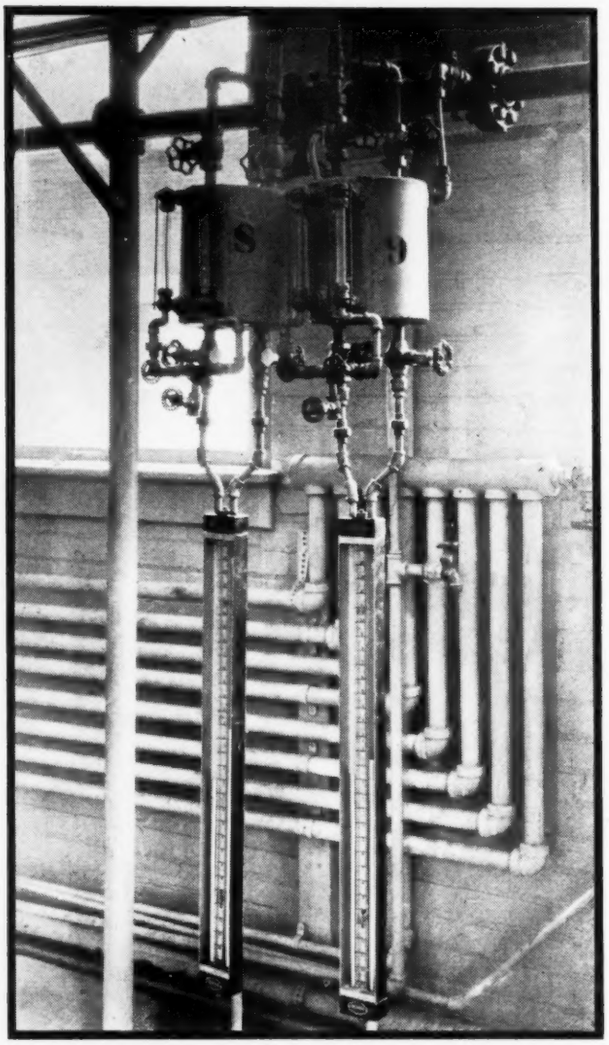
This article covers the tests made to calibrate the various metering devices, water being used as the calibrating fluid. Tests using oils of varying viscosities are now in progress and will be continued until this work is completed, which it is estimated will be two years at least.

An idea of the testing set-up may be gathered from the accompanying illustrations. Assuming the pump end as the head end, the first differential producer in the line is an orifice plate with a thickness of ⅛ inch with the differential taps located at the flange, and at 2½ and 8 pipe diameters. The second differential producer is a beveled orifice with vena contracta and corner tap connection, as used in Continental Europe. The third is a nozzle having two kinds of downstream connections, one at the center line of the nozzle tip, the other well back from the tip end. The fourth differential producer is in the return line, and is a standard venturi nozzle followed by a standard venturi meter tube; and the last is the orifice fitting.

Only the data on the standard orifices and nozzles used in 3-in. and 4-in. lines will be discussed in this report as the data on the venturi nozzle and venturi meter have not been completely calculated and checked at this time. The results of the tests on orifices and and nozzles may be summarized as follows:

1. The variation of the velocity through the orifices and nozzles has very little effect on the value of the coefficient. This is because the Reynolds numbers are high, ranging approximately between 5,000 and 360,000.

2. The effect on the coefficients when the value of the d/D ratio is changed: For the flange connection on No. 1 orifice it is found that the coefficient increases slightly with an increase in d/D ratio. On the 2½ and 8 pipe diameter connections the increase in coefficient value is quite marked. In the latter case the coefficient depends largely on the friction drop across the orifice, which decreases rapidly when the orifice diameter is increased. With both the vena contracta and the corner tap connections across the second orifice plate



Orifice flanges and manometers with separating chambers

there is but very little change in the coefficient value for different d/D ratios. A direct comparison cannot be made of nozzle coefficients as the length of the different nozzles is not the same. The coefficients for orifices and nozzles are given in Tables 3 and 4.

3. To determine whether or not having differential producers in series affected the accuracy of results, one plate was removed from the line and a test made at the same rate as before. The results of these tests are shown in Table 3. The rates of flow for runs 19, 37, and 38 were approximately the same. For run 19 there was a plate in each orifice flange, while for the runs 37, and 38 the first plate was removed. A like comparative test was made with runs 21, and 36.

Fluid Meters Test Equipment: The general layout with location of the various pieces of equipment is shown in the accompanying photograph. The test sections are made up of standard black pipe. The orifice and nozzle flanges are standard with the exception of the corner tap type, this being made special. The various differential producers are arranged in a manner that is geometrically similar, the geometrical dimensions being taken from the upstream faces of the various differential producers.

On all lines the first differential producer is an orifice of Foxboro make. Connections used are flange and 2½ and 8 pipe diameters. The next in line is an orifice of the Metric Metal Works make. The connections used are vena contracta and corner tap type. On all but the 4-in. line the vena contracta taps are made through the use of a filler piece. At the next flange nozzles are used. Two connections are made here, one within the area between the tip of the nozzle and the flange and the other having its center line the tip of the nozzle. The 4-in. venturi nozzle and venturi meter are located in the 4-in. return line. For low rates of flow a 2-in. venturi meter is used in a bypass.

First Procedure: At no time have the preliminaries, which are necessary before starting a run, been rushed to a point where the accuracy of results might be affected. The preliminaries generally consisted of circulating the fluid for a period of time until all conditions became constant. The fluid in the case of the runs included in this report has been water.

The water flowed from the lower volume tank through a control valve into a constant suction head chamber, thence to the pump, which forced it through the heat-exchanger, surge tank, test run, and back to the lower tank through piping, which was arranged to give a constant discharge head regardless of whether the water flowed to the upper or lower tank. After the water circulated for the necessary period for all conditions to become constant it was diverted to the upper tank through the use of two air-actuated valves. At the instant this diversion was made a stop watch and a stop clock were started.

During the test one man operated the suction head control valve, maintaining a constant suction pressure on the pump. Four men observed and recorded the readings of inlet and outlet temperatures of flowing fluid, inlet and outlet pres-

TABLE 1

Dimensions for Vena Contracta Taps

Pipe Size	Int. Pipe Dia. "D".	Orifice Dia. "d"	Orifice Ratio d/D	Vena Contracta Tap
4"	4.026"	0.603	0.1498	3"
		1.342	0.3333	$2^{15}/_{16}$"
		2.080	0.5166	$2^{9}/_{16}$"
		2.818	0.7000	$1^{7}/_{8}$"
3"	3.068"	0.460	0.1499	$2^{5}/_{16}$"
		1.022	0.3331	$2^{3}/_{16}$"
		1.585	0.5166	2"
		2.147	0.6998	$1^{7}/_{16}$"
2"	2.067"	0.310	0.1500	$1^{9}/_{16}$"
		0.688	0.3328	$1^{1}/_{2}$"
		1.068	0.5167	$1^{5}/_{16}$"
		1.446	0.6996	$1^{5}/_{16}$"
1½"	1.610"	0.241	0.1497	$1^{1}/_{4}$"
		0.536	0.3329	$1^{3}/_{16}$"

TABLE 2

Dimensions for Nozzle Taps

Pipe Size	Int. Pipe Dia. "D".	Nozzle Dia. "d".	Nozzle Ratio d/D.	Nozzle Tap
4"	4.026"	0.603	0.1498	$2^{9}/_{16}$"
		1.342	0.3333	$2^{5}/_{16}$"
		2.080	0.5166	$2^{9}/_{16}$"
		2.818	0.7000	$3^{1}/_{8}$"
3"	3.068"	0.460	0.1499	$1^{9}/_{16}$"
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		0.688	0.3328	$1^{5}/_{16}$"
		1.068	0.5167	$1^{3}/_{8}$"
		1.446	0.6996	2"
1½"	1.610"	0.241	0.1497	1"
		0.536	0.3329	1"
		0.832	0.5168	1"
		1.127	0.7000	$1^{3}/_{16}$"

NOTE ON TYPES OF CONNECTIONS

Coefficient C_1—Flange connection with Foxboro orifice plates.
Coefficient C_2—2½ and 8 diameter from Foxboro orifice plate.
Coefficient C_3—Corner tap connection with Metric orifice plate.
Coefficient C_4—Vena Contracta connection with Metric orifice plate.
Coefficient C_5—For 0.603 and 2.080 nozzles:
Upstream,—one diameter;
Downstream,—Inside end of nozzle;
For 1.342 and 2.818 nozzles:
Upstream—one diameter;
Downstream—at end of nozzle.

NOTE—A list of equipment used in connection with the research described in this article appears on page 82.

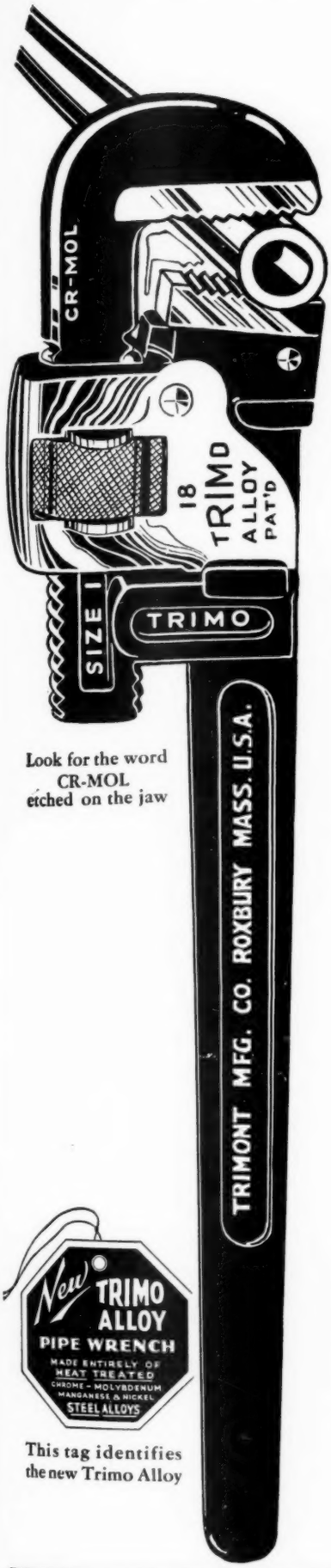

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TABLE 3

Meter Coefficients Determined for Four-Inch Pipe for Water

Run	Orifice Diam.	Temp. of Fluid	Velocity through Orifice	Flange Taps		2½x8 Pipe Diam.		Corner Tap		Vena Contracta		Nozzle (see note)	
				Diff. Press	C_1	Diff. Press	C_2	Diff. Press	C_3	Diff. Press	C_4	Diff. Press	C_5
11.	0.603	58	16.8	11.55	.6005	11.19	.6101	11.44	.6034	11.52	.6013	4.65	.9468
17.	0.603	63	17.3	12.15	.6026	11.79	.6115	12.05	.6050	12.04	.6051	4.91	.9480
12.	0.603	59	20.7	17.33	.6037	16.85	.6123	17.17	.6066	17.20	.6060	6.96	.9527
14.	0.603	66	20.0	16.13	.6043	15.69	.6126	15.91	.6084	15.99	.6070	6.45	1.0063†
18.	1.342	65	12.8	6.06	.5972	5.27	.6401	5.87	.6057	5.96	.6022	2.27	.9752
23.	1.342	65	12.7	5.79	.6039	5.01	.6490	5.64	.6118	5.70	.6089	2.03	.9796
19.	1.342	67	17.7	11.48	.5986	10.07	.6393	11.22	.6056	11.34	.6023	4.27	.9821
*37.	1.342	70	17.2	.....	.....	.....	.....	10.59	.6050	10.66	.6029	4.09	.9730
*38.	1.342	69.5	17.4	.....	.....	.....	.....	10.83	.6051	10.88	.6036	4.20	.9712
21.	1.342	68	22.0	17.82	.5972	15.54	.6393	17.39	.6048	17.55	.6018	6.62	.9801
*36.	1.342	72	22.3	.....	.....	.....	.....	18.03	.6019	18.18	.5992	7.01	.9654
25.	2.080	68.5	12.4	5.71	.6103	4.11	.7192	5.69	.6111	5.73	.6091	2.21	.9808
26.	2.080	69	12.4	5.73	.6103	4.06	.7247	5.71	.6112	5.78	.6075	2.22	.9797
27.	2.080	70	18.4	12.52	.6110	8.91	.7239	12.46	.6121	12.55	.6100	4.79	.9871
28.	2.080	78	18.4	12.57	.6109	8.94	.7243	12.49	.6129	12.61	.6099	4.79	.9899
29.	2.080	78	20.9	16.06	.6118	11.41	.7258	16.01	.6127	16.19	.6092	6.11	.9916
30.	2.080	77	20.7	15.83	.6109	11.30	.7231	15.82	.6111	15.82	.6110	6.04	.9891
33.	2.818	73	7.45	1.65	.6242	.84	.8732	1.75	.6062	1.67	.6193	.69	.9676
34.	2.818	89	7.62	1.67	.6275	.87	.8717	1.79	.6061	1.73	.6171	.71	.9648
31.	2.818	98	11.7	3.84	.6327	2.00	.8774	4.04	.6167	.....	.....	1.64	.9691
32.	2.818	95	11.6	3.77	.6324	1.98	.8738	4.07	.6086	3.96	.6170	1.59	.9737
35.	2.818	87	11.6	3.78	.6322	1.96	.8778	4.05	.6109	3.92	.6209	1.62	.9649

*Orifice Plate omitted at No. 1 Flange.

†Air in Separating Chamber.

sures, and differential pressures on the various manometers. Each man made a number of complete readings of all data taken instead of individuals being assigned to read certain manometers and the like. After approximately 80 bbl. of water were pumped the flow was diverted back to the lower tank and the time noted. A portion of the observers weighed the fluid while the others calculated the observed data.

As soon as the weighing was completed the fluid was circulated preparatory for a run at either a check or different rate, depending on accuracy of final results, which were computed before another test was started.

Discussion of the Data and Results as to Accuracy: To obtain the average differential on any manometer for the run, the average of all readings was taken instead of the average of the square roots. This was done on the assumption that the flow was constant and that the difference in the readings was due to inaccuracy on the part of the reader. The manometers were read to one hundredth of an inch. In changing mercury differential to feet of flowing liquid, the manometer was considered at room temperature in finding the true differential. This conversion and density correction was given by a curve. With the use of this curve it is assumed that the flowing temperature is the same as the room temperature. Although this was not quite true, the correction would have been out to the fourth place in the coefficient.

The weighing scales were calibrated and correction charts drawn for both scales. These correction charts were made up thus: Two people checked the reading on each scale so as to catch all errors resulting from weighing.

There was some dissension regarding the coefficient of the second test section being affected by the first test section, so the first orifice plate was removed and check runs made on the second orifice.

Results and Conclusions: All calculations were carried out by a calculating machine. All the coefficients were figured from the common hydraulic formula: $Q =$

$$C\,a\,\frac{2\,g\,h}{1 - (d/D)^4}$$

where Q is the quantity flowing in cu. ft./sec., C is the coefficient, a is the area of the differential producer in sq. ft., g is the gravitational constant (32.14), h is the head differential in ft. of flowing liquid, d is the diameter of orifice in feet, and D is the diameter of pipe in feet. Coefficients were calculated for the vena contracta connection, flange connection, corner tap connection and 2½ and 8 diameter connections for the orifices. The coefficient for the nozzle was calculated but two different connections were used so all nozzle coefficients cannot be compared.

All flow conditions were run twice so as to have a check. In case they didn't check more runs were made.

The results obtained on the water calibration tests compare favorably with the work done by the investigators in this and foreign countries.

TABLE 4

Meter Coefficients Determined for Three-Inch Pipe for Water

Run	Orifice Diam.	Temp. of Fluid	Velocity through Orifice	Flange Taps		2½x8 Pipe Diam.		Corner Tap		Vena Contracta		Nozzle (see note)	
				Diff. Press	C^1	Diff. Press	C^2	Diff. Press	C^3	Diff. Press	C^7	Diff. Press	C_1
42.	0.460	73	17.16	11.5	.6165	11.23	.6238	12.35	.5949	12.39	.5938	4.69	.9656
47.	0.460	71	17.03	11.35	.6158	11.02	.6252	12.16	.5951	12.17	.5948	4.62	.9657
41.	0.460	74	21.25	17.82	.6133	17.27	.6229	18.97	.5944	19.01	.5838	7.11	.9707
46.	0.460	72	21.07	17.44	.6145	16.98	.6228	18.64	.5945	18.66	.5942	7.02	.9686
49.	0.460	68.5	20.69	16.88	.6137	16.33	.6240	17.96	.5949	17.97	.5947	6.80	.9667
50.	1.022	106	10.54	4.42	.6070	3.85	.6510	4.47	.6024	4.51	.6014	1.71	.9769
51.	1.022	102	10.64	4.52	.6060	3.01	.6516	4.47	.6094	4.56	.6036	1.75	.9742
59.	1.022	93	11.08	4.95	.6029	4.25	.6509	4.76	.6035	4.95	.6032	1.92	.9693
52.	1.022	98	15.21	10.63	.6026	9.22	.6472	10.60	.6033	10.74	.5995	4.01	.9811
53.	1.022	97	16.10	10.46	.6029	9.07	.6474	10.43	.6038	10.55	.6003	3.97	.9788
54.	1.022	95	16.16	10.55	.6028	9.14	.6476	10.49	.6044	10.61	.6011	4.00	.9793
58.	1.022	94	16.78	11.32	.6040	9.80	.6490	11.31	.6044	11.39	.6020	4.28	.9821
55.	1.022	94	20.64	17.05	.6053	14.82	.6493	17.02	.6057	17.23	.6020	6.47	.9825
56.	1.022	93	20.65	17.15	.6038	14.90	.6476	17.10	.6045	17.30	.6011	6.48	.9819
57.	1.022	97	19.93	15.92	.6049	13.85	.6487	15.98	.6038	16.00	.6035	5.96	.9884
60.	1.585	89	10.88	4.35	.6129	3.09	.7271	4.43	.6073	4.48	.6038	1.73	.9703
63.	1.585	62	12.33	5.58	.6125	3.88	.7346	5.63	.6100	5.66	.6083	2.20	.9762
62.	1.585	88	17.85	11.50	.6175	8.22	.7304	11.82	.6093	11.94	.6062	4.54	.9833
64.	1.585	61	17.88	11.52	.6189	8.19	.7341	11.85	.6101	11.93	.6082	4.59	.9809
65.	1.585	61	22.60	18.40	.6185	13.11	.7327	18.97	.6092	19.09	.6073	7.32	.9810
66.	1.585	62	22.06	17.58	.6177	12.56	.7306	18.07	.6092	18.15	.6079	6.97	.9809
67.	2.147	64	14.96	6.10	.6436	3.20	.8882	.....	.....	.....	.....	.....	.....
68.	2.147	65	15.03	6.24	.6394	3.23	.8882	.....	.....	.....	.....	.....	.....
69.	2.147	66	14.95	6.20	.6378	3.25	.8812	.....	.....	.....	.....	.....	.....
71.	2.147	60	14.57	5.87	.6390	3.02	.8908	6.61	.6032	6.34	.6149	2.44	.9915
74.	2.147	71	15.00	6.17	.6414	3.21	.8890	6.93	.6056	6.96	.6024	2.60	.9882
75.	2.147	73	14.95	6.29	.6336	3.20	.8885	6.91	.6043	6.66	.6158	2.58	.9884
70.	2.147	66	19.94	11.08	.6365	5.74	.8840	.....	.....	.....	.....	.....	.....
72.	2.147	59	20.08	11.04	.6433	5.76	.8891	12.49	.6039	12.08	.6138	4.59	.9956
73.	2.147	59	19.75	10.82	.6381	5.62	.8851	12.15	.6021	11.71	.6133	4.48	.9913

Notes on Absorber Design

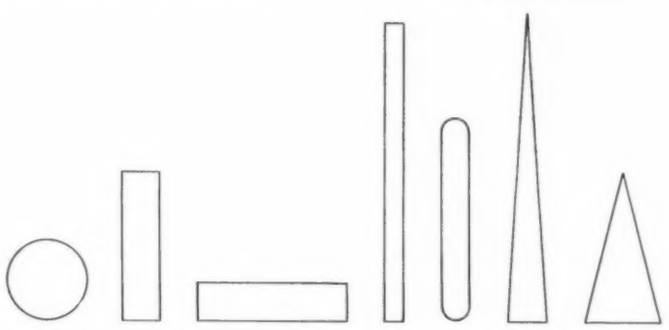
By F. L. KALLAM

Industrial Engineers, Inc.,
Los Angeles, California

ARTICLE I

EXPERIENCE has indicated that the most efficient type of fractionating column, when back pressure is of no great importance, is the so-called bubble cap tower. This type of apparatus has been unanimously adopted by the refining industry for practically all its gas-liquid reactions. As a result, the design of such columns is a factor in the success or failure of many of the processes involved. The information on which column design is based, however, is a mixture of scientific and empirical data. In the absence of carefully made experimental data, past experience is relied upon to a great extent and is largely responsible for the accepted theories and practices.

As an example, it is now tradition that bubble caps should have small perforations in order to produce the very desirable small gas bubbles. Another belief is that sharp-edged triangular or inverted "V" notches in caps permit a greater degree of flexibility when operating with variable gas loads. Similarly, the length of the downspout perimeter is increased by various expedients in order to increase the liquid throughput of the column. Actual test data obtained in the laboratory and in the field on towers operating as absorbers do not entirely substantiate all these views.



FIGURE~1.
SHAPES OF PERFORATIONS USED TO PRODUCE BUBBLES
AREA OF EACH ORIFICE 1/64 SQUARE INCH

Effect of Orifice Shape and Submergence Upon Performance

In one series of experiments, perforations of identical areas, but of different shapes, were utilized as gas orifices. The shapes of these openings are given in Fig. 1. Each orifice was subjected to the same submergence in oil and to the same air pressure. In every case the bubbles produced were of the same size and shape regardless of the character of the forming orifice.

At low air rates the bubbles left the orifice in a pear shape but immediately flattened out in rising as indicated in Fig. 2A. For higher rates, or high air velocities through the orifice, the air discharged in the form of a vortex as shown in Fig. 2B. For these cases the bubbling effect was minimum. The appearance at the surface of the oil, however, was as though the bubbling effect was perfect and equal to that obtained with low air rates at the orifices. A side view of this condition through the glass container disclosed that the bubbling appearance resulted purely from agitation at the liquid surface.

Another series of tests was made using orifices of the size and shape given above. These tests disclosed the fact that considerable air had to be used before the lower perforations could be forced to emit bubbles. Only the highest opening, with possibly the very top part of the next one below, could be brought into operation at anywhere near reasonable air rates. In Fig. 3 is given a typical arrangement of one set of orifices used in these experiments. Particular attention is called to the close vertical spacing of the perforations, the top point of the highest orfice being but five-eighths of an inch above the bottom of the lowest opening.

The data presented in Fig. 4 were obtained from the tests on the orifice arrangement given in Fig. 3. It will be noticed that for low submergences, as two and three inches, it was possible to release the air at the bottom of the top perforations at little increase in pressure drop over that required to produce bubbling from the top of the same orifice. On the other hand, to release air at a distance of five-eighths of an inch (point 5, Fig. 3) below the top of the initial orifice, required an increase in pressure differential of more than 11 times that required to produce bubbling from the top of the first orifice. Increasing the average submergence distance to six inches appears to bring about a more uniform relationship between the pressure required to produce the bubble and its depth of release. Finally, with a 9-in. submergence, the pressure increment required is practically proportional to the depth of air release.

If efficiency of contacting gas and liquid depends upon the ability of an apparatus to produce small bubbles, then these various tests demonstrate that the shape of the producing orifice has no influence. Within commercial limits, however, the orifices should be small in area. Further, high gas velocities through the perforations do not result in the formation of small bubbles, regardless of the orifice size, but rather in a vigorous channeling of the gas through the liquid. Under this condition, the liquid surface is violently disturbed, giving to bubble formation at this point alone.

FIGURE~2.
GENERAL SHAPE OF BUBBLES PRODUCED

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Photo by Lloyd M. Long

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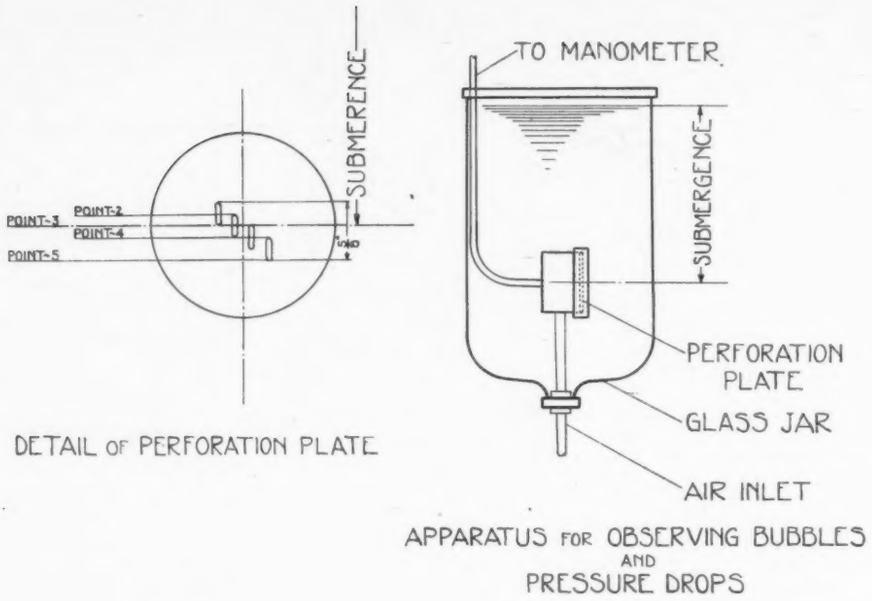


Fig. 3. Arrangement for observing bubble phenomena

These conclusions are further verified by those cases of deep submergence, requiring appreciable pressure in order to release the gas, and resulting in the production of few actual bubbles. The use of low submergences, aside from resulting in actual bubble production, has the additional advantage of lower pressure drop. Under these conditions, it is possible to produce bubbles at various depths without a proportional increase in pressure differential, as is the case with deep submergences.

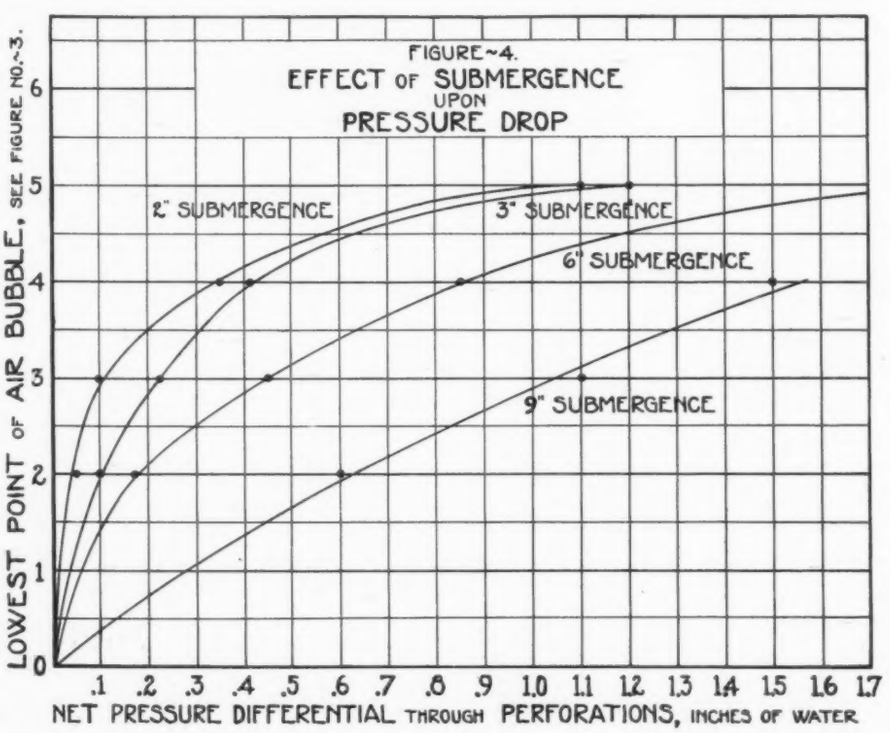
The writer, as stated on numerous occasions, cannot subscribe to the theory that the efficiency of contact depends upon the bubbles rising through the liquid. In a commercial absorber a geyser effect exists rather than a true bubbling action, and yet a fair degree of extraction efficiency is obtained. Neither is it felt that the contacting of the vapor at the top surface of the liquid is over important. For here again in actual absorber operation will a froth be produced. Although the efficiency does depend to some extent upon the combination of these two effects, it is governed principally by the contacting of the vapor and the drops of liquid in the vapor space above the liquid. Thus, in the design of a bubble plate it is important to provide for a misting of the liquid into the vapor space. Certain types of misting equipment bear this theory out, notably the rotary scrubber, which operates at high efficiencies without the production of a single bubble. Many present-day bubble plates operate at higher than known efficiencies, but the effect is destroyed because of the entrainment of the liquid in a mist form from plate to plate.

The plate efficiencies of commercial towers, especially those of large diameter, are materially reduced because of the inactive portion of the plates. From the experiments cited, it is obvious that the gas will always rise where the liquid head is lowest, or where the resistance to flow is least. This point is that side of the bubble plate nearest the overflow weir, made so by reason of the liquid gradient required to cause liquid flow across the plate itself. The percentage of the caps in operation on a commercial plate is governed by the vapor rate and not by the liquid load. For superficial gas velocities (that is, velocities above the liquid in the vapor space) of 0.5 ft. or less per sec., the bubbling will take place next to and near the overflow weir. For velocities of the order of one ft. per sec., bubbling can be produced over an area of about one-half the tower on the overflow weir side. The action in either case is not steady or uniform, but surging from one group of caps to another over the area specified. There is thus a great need for keeping the tower diameter as small as possible in order to minimize the effect of gas channeling. Plate design should also provide means for keeping the cap submergences equal across the entire surface of the plate.

Effect of Downspout Design Upon Column Capacity

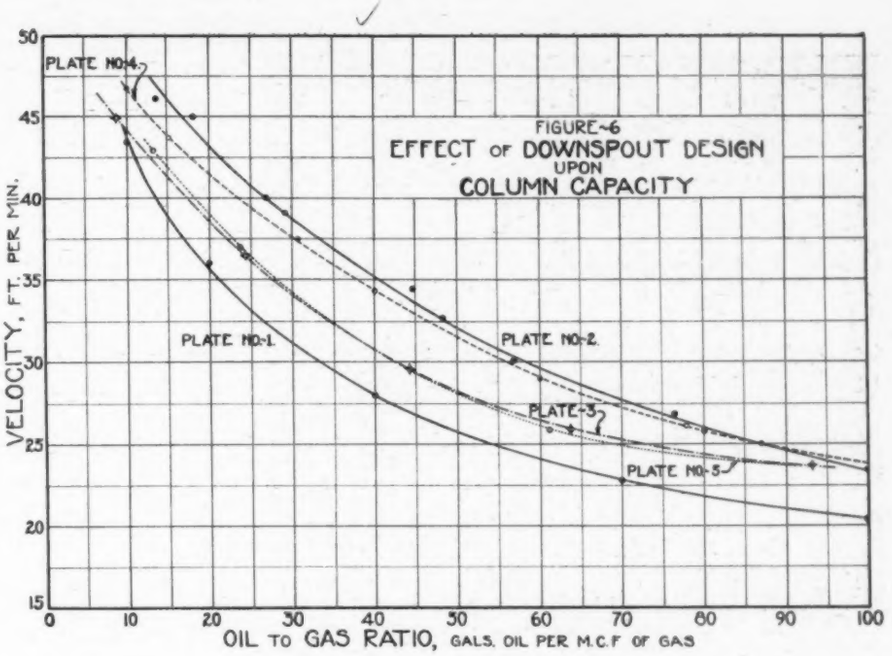
The importance of proper downspout design upon the capacity of fractionating towers has long been recognized. As there have been practically no data available upon this phase of tower design, two schools of thought have developed. One of these advocates that the column throughput can be increased by increasing the periphery of the downspout. The second school disregards this view and advocates that the area of the downspout is the controlling factor.

In an effort to throw some experimental light upon these two contentions, certain tests were made. Five bubble plates



were designed having identical diameters and bubble caps. The peripheries and areas of the downspouts on each plate, however, were varied. In Fig. 5 will be found the plan of each plate as well as the relative values of each of the dimensions. For simplification, and to avoid confusion, the bubble caps are not shown.

The capacities of each of these bubble plates were determined by using compressed air and absorption oil of 0.864 specific gravity. In testing, the procedure was to run stated air volumes to each plate, increasing the oil flow to a maximum point that it could be passed through the downspout. A plot of the data so obtained is given in Fig. 6. Here the oil to gas ratio is plotted against the actual air velocity through the tower, the diameter of the latter being that of the plates.



An inspection of these data shows that Plate 2 gives the greatest capacity even though the downspout periphery is approximately one-half of that of Plate 4 and 5. Plate 4, which is second in point of capacity, has an area equal to that of Plate 2. With the exception of the data from Plate 5, the remaining curves tend to show that the capacity varies as the downspout area. This suggests that area is one of the governing factors of capacity; periphery being a minor one.

The fact that Plate 2, with a downspout area equal to Plate 4, but with less periphery, is substantially superior in capacity, intimates that there is still another controlling factor. This factor will be termed, "fall-distance," and is the horizontal distance from the weir of the downspout to the point that the oil first strikes in flowing over the weir.

In order to study the influence of this new factor upon downspout capacity, it was necessary to observe the trajectory of oil flowing over a weir. For this purpose, a flat glass tower was constructed, which permitted actually tracing the course of the oil over the downspout weir. The procedure was first to trace the trajectory of the oil flowing over the weir at a definite head, but without employing air through the bubble caps. When this was completed, air was turned through the oil, and the new contour traced for this flow condition. The results of such investigation were a system of more or less uniform curves, and these are shown in Fig. 7.

The solid lines in Fig. 7 were obtained without air-agitation, and are thus indications of the oil to gas ratios employed. It should be observed that a decrease in this ratio, as from curves 5 to 1, is not followed by a corresponding lessening in the fall-distance, as shown by curves 5^1 to 1^1. This latter distance decreases very much more slowly than the change in oil to gas ratio. Indications are that the fall-distance, measured four inches below the top of the downspout weir, should not be less than $1\frac{3}{4}$ inches. Under these conditions no interference will be encountered from the side of the downspout.

As some downspouts are designed to handle an overflow from both the front and backsides, further tests were made to determine the effect of these two streams of oil interfering with each other. In Fig. 8 is shown the result of one such test, using weirs placed two inches apart. Curves 1 show an oil flow that can be adequately handled, even when agitated with air as indicated in curves 1^1. Increasing the oil rate to the position shown by curves 2 also could be successfully handled, but without the air-agitation. In this latter case, the condition of flow changed to the curves 2^1, which interfered at point "A" so as to fill entirely the downspout. The oil entering the downspout also indicated a surging, or better, a breathing action, which caused flooding of the entire plate. It appears that downspouts of this design should never be less than two inches wide if successful operation is to be obtained.

These demonstrations bring out the importance of the fall-distance and show why it is necessary to design a downspout to effect the full advantage of the total area available. The superiority of Plate 2 over Plate 4, in Fig. 6, can now be understood. The former has the decided advantage that its downspout area is practically all workable, while the latter, despite its greater periphery and equal area, is penalized because the fall-distance is such as to let the oil interfere with itself in passing over the two weirs. This case is analogous to that of two heat interchangers of equal surface, the one

	PLATE-1	PLATE-2	PLATE-3	PLATE-4	PLATE-5
PLATE AREA, SQ. FT.	0.338	0.338	0.338	0.338	0.338
DOWNSPOUT AREA, SQ. IN.	1.48	7.33	1.65	7.33	5.15
DOWNSPOUT PERIPHERY, INS.	4.32	6.50	6.50	13.80	13.80

Fig. 5. Arrangement of experimental bubble plates. (Caps not shown)

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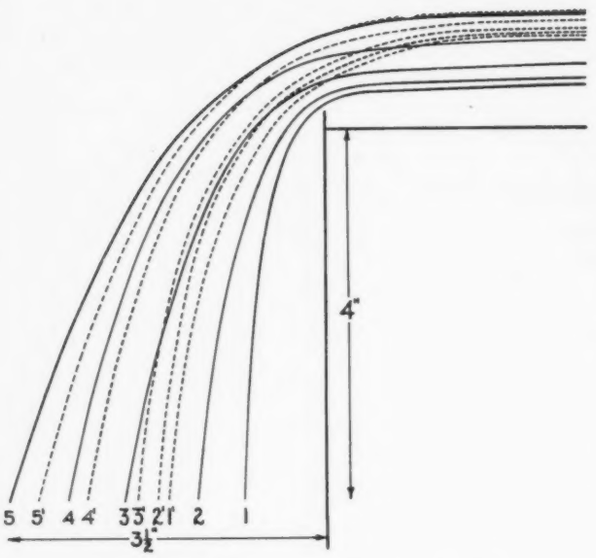

Fig. 7. Oil flow over downspout weir

having all this surface arranged to be effective, and the other, only a portion. The amount of heat transferred, and hence the efficiency, is all in favor of the first exchanger.

The factors just discussed are a few of the reasons why downspout design cannot follow the dictate of the Francis weir formula, as is so often stated. The adequacy of the downspout has a marked bearing on the upper limit of oil capacity, and thus is related to the carrying effect from plate to plate. When oil is mechanically carried from plate to plate the fractionating efficiency of the tower is lowered. Area of the downspout is of greater importance than perimeter, but this area must be workable as governed by the fall-distance. The oil capacity of the downspout is thus dependent primarily upon that portion of the downspout that is "workable."

(Article 2 will appear in the May issue—Editor.)

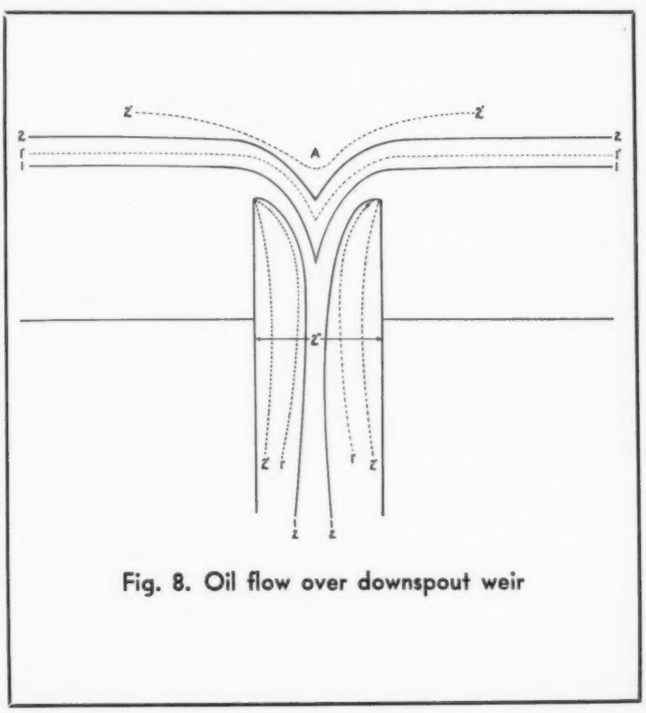

Fig. 8. Oil flow over downspout weir

FORT WORTH

HOST TO

Southwestern District, Division of Production

AMERICAN PETROLEUM INSTITUTE

BLACKSTONE HOTEL

April 20-21 1934

TEXAS ELECTRIC SERVICE COMPANY

General Offices: FORT WORTH

PROGRAM

SPRING MEETING - SOUTHWESTERN DISTRICT
A. P. I. DIVISION OF PRODUCTION

FRIDAY MORNING SESSION—9:30 A. M., APRIL 20th

"Vocational Training in the Oil Industry"

By Geo. H. Fern, Director Industrial Education, Austin, Texas. (This paper describes the facilities available on vocational training to the oil industry under the Federal Smith-Hughes Act of 1917, and the progress made to date in forming classes and developing courses of study on practical production subjects).

"Killing Crater Well at Conroe"

By John R. Suman, Humble Oil & Refining Co. (An informal talk illustrated by lantern slides, describing the equipment and methods used in killing the Harrison-Abercrombie Alexander No. 1 cratered well at Conroe. This was an unusual engineering feat).

"Recent Developments in Production Equipment and Methods"

Joint paper by J. M. Cooper and T. W. Rhoads, Gulf Production Company. (Discusses slow speed pumping, insert pumps, plunger pumps, improvements in standard rig construction, high temperature in acid treatment of wells, use of vacuum bailer in cleaning wells, and other interesting developments).

12:15—LUNCHEON

The Oil and Gas Division of the Fort Worth Chamber of Commerce is sponsoring a special luncheon for the visitors in the Blackstone Hotel. Mr. W. R. Boyd, Jr., executive vice-president of the American Petroleum Institute, is the principal speaker.

FRIDAY AFTERNOON SESSION—2:00 P. M., APRIL 20th

"The National Petroleum Code"

Entire session devoted to a general discussion of the national petroleum code by the officers of the Texas Production Committee of the Regional Planning and Coördinating Committee, District No. 4. Various aspects of the work will be covered by the chairmen of the respective sub-committees that have been appointed.

"General Function and Purpose," by L. E. Barrows, The Texas Company, Chairman.

"Allocation Committee," by Jack Pew, Sun Oil Company, Chairman.

"New Pools Committee," by F. C. Sealey, The Texas Company, Chairman.

"Stripper Wells Definition Committee," by P. B. Flynn, Reno Oil Company, Chairman.

"Drilling Practice Committee," by J. H. Russell, Gulf Production Company, Chairman.

"Enforcement Committee," by R. L. Wheelock, Chairman.

"Purposes and Function of the American Petroleum Equipment Industry and Trade," by W. L. Childs.

Annual election of officers and advisory committee, Southwestern District.

Report of nominating committees.

SATURDAY MORNING SESSION—9:30 A. M., APRIL 21st

"Practical Application of Accident Prevention"

By C. L. Hightower, Texas Pacific Coal & Oil Company. (This paper discusses the benefits that accrue from the use of a practical accident prevention program in production work; cost of accident prevention versus compensation rates is also covered).

"Use of Flush-joint Casing and Drill Pipe"

By Dr. W. V. Vietti, The Texas Company. (A discussion of the increasing use of flush-joint casing and drill pipe in the Gulf Coast area).

"Pressure Completions of Wells in West Texas"

By E. V. Foran, Consulting Engineer. (This paper describes the methods and apparatus used in completing, under control, high-pressure wells in West Texas).

"Changes in Hydrostatic Pressure Caused by Movement of Drill Pipe"

By Geo. E. Cannon, Humble Oil & Refining Co. (A survey of recent blowouts reveals that a large majority of blowouts occur while the drill pipe is being withdrawn. This paper includes a survey of pressures observed during this operation, as well as other information on control of high pressures with rotary muds).

Adjournment.

There will be no afternoon session on Saturday.

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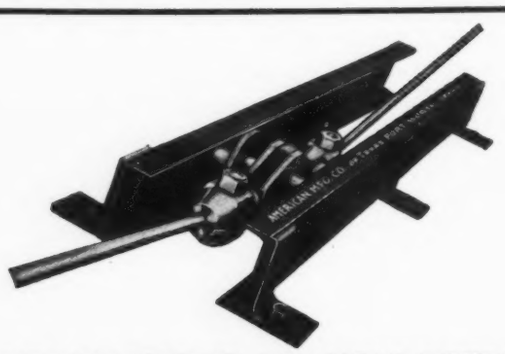

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Southwestern District Chapters Among Most Active of A. P. I.

A PROGRAM of unusual interest and value has been arranged for the annual spring meeting of the Southwestern District, Production Division, of the American Petroleum Institute, to be held at the Blackstone Hotel in Fort Worth, Texas, April 20 and 21.

Because of the widespread interest in the national petroleum code, one entire session (Friday afternoon) is being given over to the consideration of that subject. Various aspects of the code, as well as allied codes, will be presented by well-known speakers.

The other two sessions are being devoted to papers and discussions on technical and mechanical subjects. Among these is a paper on vocational education in the producing branch of the industry, and one on the practical application of accident prevention, both subjects of timely interest, the latter because of the increasing compensation rates in the Southwestern area.

In addition to the business sessions, the Oil and Gas Division of the Fort Worth Chamber of Commerce is sponsoring a special luncheon, to be held in the Blackstone Hotel, with W. R. Boyd, Jr., executive vice-president of the American Petroleum Institute, as the principal speaker.

The complete program will be found on a preceding page of this issue of *The Petroleum Engineer*.

The Southwestern District of the American Petroleum Institute includes the states of Texas, Louisiana and Arkansas, with chapters at Wichita Falls, East Texas and Eldorado, Arkansas. These chapters, organized slightly more than three years ago, have been meeting approximately once a month, carrying on a program of development and education of great value to the members. At each meeting one or more papers are presented dealing with subjects of vital interest, and, during the past year, considerable work has been done in the field of vocational training.

Members of the various committees handling arrangements for the Fort Worth meeting worked diligently in preparing a program of outstanding merit and are deserving of much credit. Personnel of the committees follows:

General Committee

E. A. Landreth, Chairman, Landreth Production Company; F. J. Adams, Gulf Production Company; L. E. Barrows, The Texas Company; J. D. Collett, Collett & O'Keefe; W. P. Dinkins, Sinclair-Prairie Oil Company; John Hancock, Texas Pacific Coal & Oil Company; J. M. Loffland, Loffland Brothers Drilling Company; A. M. McCorkle, Stanolind Oil and Gas Company; George McIntyre, Continental Oil Company; Charles Roeser, Roeser & Pendleton; B. S. SoRelle, Pure Oil Company; Stanley Thompson, Westbrook & Thompson.

Arrangements Committee

E. H. Griswold, Chairman, Continental Oil Company; Frank Harold, Consulting Geologist; H. B. Thomson, Pure Oil Company; C. B. Williams, The Texas Company.

Registration Committee

R. H. Fash, Chairman, Fort Worth Laboratories; M. J. Hoffman, Stanolind Oil and Gas Company; T. W. Rhoads, Gulf Production Company.

Luncheon Committee

Stanley Thompson, Chairman, Westbrook & Thompson; Charles Fitzgerald, Sinclair-Prairie Pipe Line Company; C. C. Patterson, Chamber of Commerce.

Program Committee

W. T. Doherty, Chairman, Humble Oil & Refining Co., Houston, Texas; C. B. Clement, The Texas Company, Wichita Falls, Texas; Paul Hubbard, Gulf Production Company, Houston, Texas; Melbert Schwarz, Texas Seaboard Oil Company, Dallas, Texas; R. B. Kelly, Pure Oil Company, Fort Worth, Texas; J. E. Warren, Group No. 1 Oil Corporation, Texon, Texas.

Southwestern District Officers

Southwestern District officers, elected at Houston April 7, 1933, and who have served during the fiscal year, include the following: John A. Ritter, Chairman, Sun Oil Company, Dallas; J. E. Warren, Vice-Chairman for West Texas, Continental Oil Company, Texon, Texas; R. D. Risser, Vice-Chairman for East Texas, Shell Petroleum Corporation, Houston, Texas; Paul Hubbard, Vice-Chairman for Gulf Coast, Gulf Production Company, Houston, Texas; C. B. Clement, Vice-Chairman for North Texas, The Texas Company, Wichita Falls, Texas; H. W. Bell, Vice-Chairman for Arkansas-Louisiana, Lion Oil and Refining Company, Eldorado, Arkansas; W. T. Doherty, Secretary-Treasurer, Humble Oil & Refining Company, Houston, Texas.

Wichita Falls Chapter

The Wichita Falls chapter has the largest enrollment of any in the Southwestern District, numbering 52. Meetings are held monthly and are always well attended. These meetings keep members informed on the latest developments in production methods, the programs consisting of one or more papers or talks on timely subjects, followed by general discussion.

Present officers of the chapter are: F. H. Williams, United Gas Company, Wichita Falls, Chairman; S. A. Wood, The Texas Company, Wichita Falls, First Vice-Chairman; R. B. Baker, Continental Oil Company, Burkburnett, Texas, Second Vice-Chairman; and G. R. Walton, Northern Texas Utilities Company, Wichita Falls, Secretary.

The Wichita Falls chapter was organized three years ago and since that time many valuable papers have been presented, among them being:

"Methods of Treating Oil," by George F. Beekman, C. R. Webb and E. E. Merkt.

"Disposition of Salt Water by the Spraying Method," by R. R. Ryle.

"Economical Methods of Treating Local Water for Oil Field Uses and Purification for Drinking Purposes," by A. H. McPherson.

"Air and Gas Lift in the Production of Oil," by Frank M. Stauffer.

"Methods Used in Constructing a Modern Pipe Line," by C. R. Burden.

"Solubility of Gas in Oil," by B. B. Lindsley.

"Repressuring, Sunshine State Pool, Archer County," by W. B. Nicholson.

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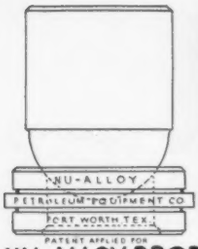

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"Gas Meters and the Measurement of Gas," by T. O. Banta.

"Proper Set-Up of Walking Beams for Pumping Wells," by C. B. Clement.

"Prevention of B. S. Trouble in Pumping Wells," by G. S. Mabron.

"Procedure to Follow in Repressure Work," by G. R. Walton.

"Methods of Treating and Results Realized from Acid Treatment of Lime Wells," by C. R. Graham.

"Equipment and Methods Used in Treating Emulsions and Cut Oil in the Nocona District," by G. F. Beckman.

"Treating Oil in the Rock Crossing Field of Wilbarger County," by Harvey Landrum.

"Eccentricities and Safe Handling of Nitroglycerine for Well Shooting," by Tom W. Mendenhall.

East Texas Chapter

The East Texas chapter, organized mid-year of 1931, now has 24 members. While the membership is not so great in number as some of the chapters, the East Texas group is composed of men whose interest is of an especially active nature. Monthly meetings have been held except during certain seasons of the year when rains put the roads in such shape that travel is almost impossible.

No small part of the chapter's activities has been the sponsoring of vocational training classes. These are held twice weekly at the Kilgore High School and have an approximate enrollment of 125.

Officers are: Harold Vance, Vance-Fagin Engineering Company, Kilgore, Texas, Chairman; D. M. Collingwood, Sun Oil Company, Tyler, Texas, Vice-Chairman; Dave Davenport, Shell Petroleum Corporation, Kilgore, Vice-Chairman; J. D. Wheeler, Mid-Kansas Oil and Gas Company, Kilgore, Vice-Chairman; and O. D. Hutto, Shell Petroleum Corporation, Kilgore, Secretary-Treasurer.

A partial list of papers presented before the chapter during its existence includes:

"The Relation of East Texas Geology to Planned Well Spacing," by R. B. Whitehead.

"Drilling and Completing Wells in East Texas," by I. L. Sorenson, C. D. Alsworth, L. C. Peters and D. W. Wofford.

"Pumping Equipment and Methods in East Texas Fields," by Harold Vance, G. L. Nye, D. V. Carter and D. T. Ross.

"Types of Pumping Equipment Suitable for Use in the East Texas Fields," by D. V. Carter.

"Paraffin Trouble in East Texas," by R. S. Christie and Mr. McQuarrie.

"History of Reservoir Pressure in East Texas," by John Ritter.

"Relationship of the Free Gas Area in the South End of East Texas Field to the Main Producing Area," by J. D. Wheeler.

"Acid Treatment of Wells," by Messrs. Best and Anderson.

"Production Control in the East Texas Field," by Gordon Griffith.

El Dorado Chapter

The El Dorado chapter draws its membership from Arkansas and Louisiana. At one time one of the most active chapters of the American Petroleum Institute, meetings have been infrequent the last three years, due to the fact that many of its active members were transferred to the East Texas field. Present officers are: W. C. O'Ferrall, Standard Oil Company, Smackover, Ark., Chairman; and George G. Moore, Root Refining Company, Eldorado, Secretary.

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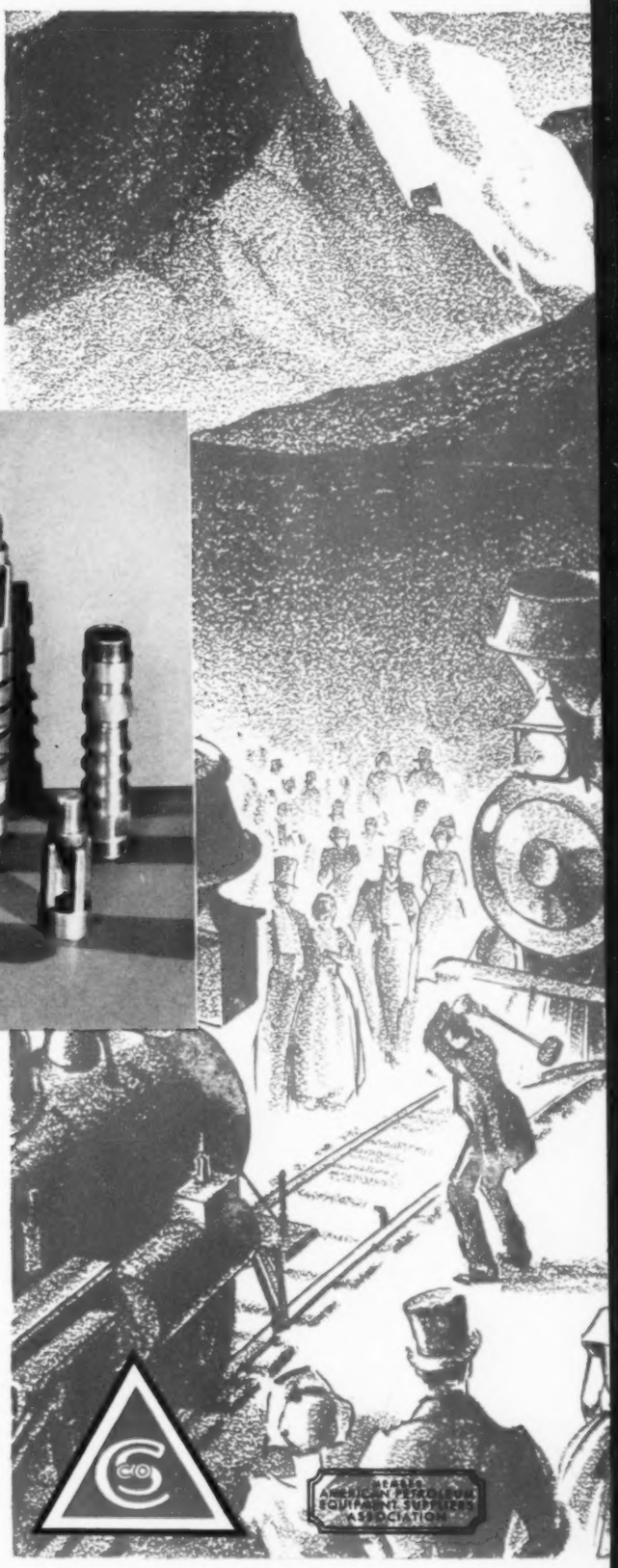

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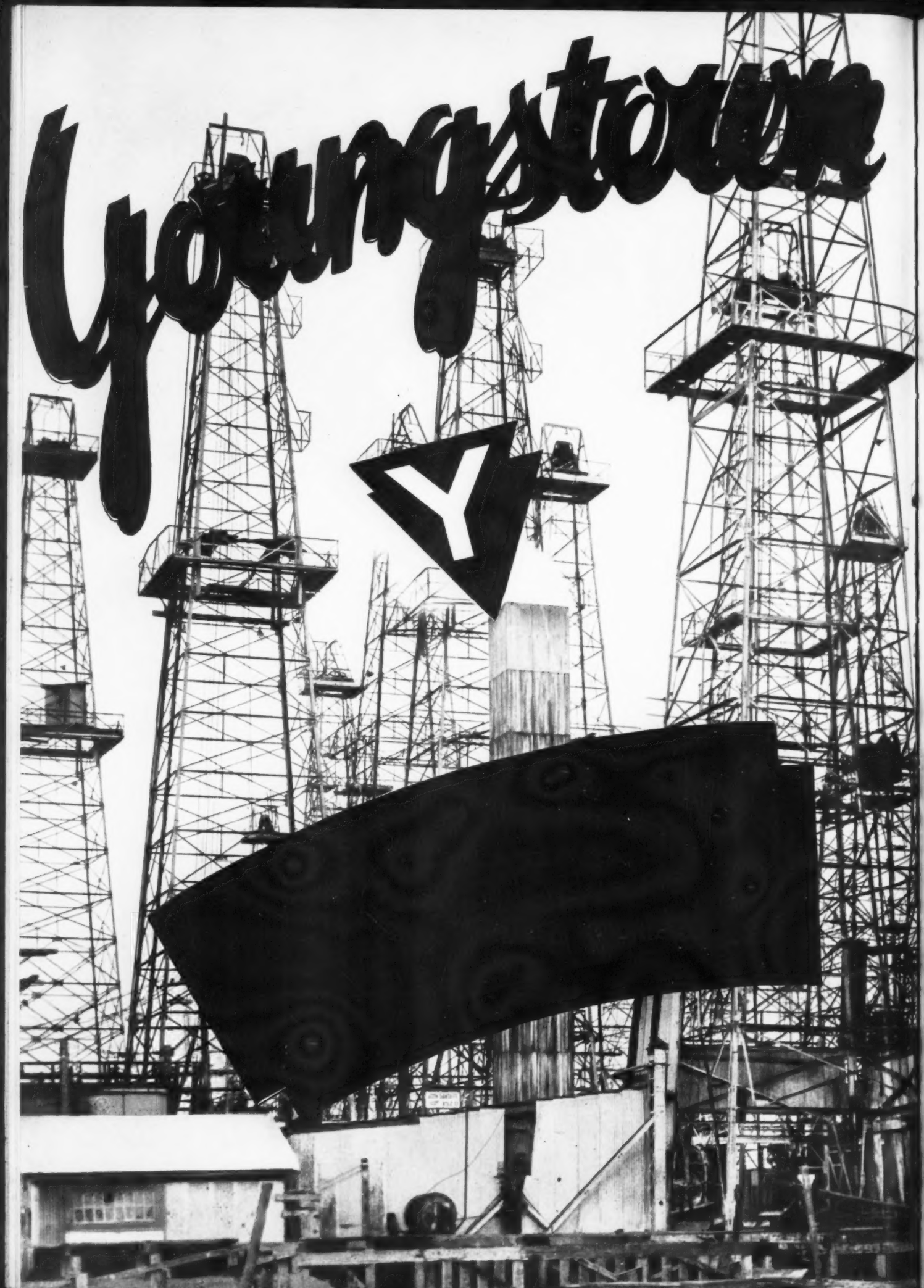
Youngstown

Effect of Pressure on Dehydration of Crude Oil Emulsions

By
WILLIAM WOELFLIN*

IT does not appear that pressure should have any effect on the dehydration of crude oil emulsions, since there is no change in volume during the process. The volume of water coming from the bottom of the dehydrator, plus the volume of clean oil over the top, will equal the volume of the crude oil emulsion going to the dehydrator.

There is, however, a definite effect of pressure, due to decreasing the amount of gas formed by preheating of the oil. This effect is more noticeable when electrical dehydration is carried out at the higher temperatures, and depends on the quantity of gas and low-boiling hydrocarbons present in the crude oil. Sufficient pressure to prevent any gas being formed has been found in some cases materially to increase the treating capacity and reduce the water content of the dehydrated oil.

Effect of Gas on Float-Controlled Switch. The release of gas inside the electric dehydrator has several detrimental effects. If there is any gas present in the upper part of the shell, it serves to form an oil-gas foam in the float control apparatus at the top of the dehydrator. This foam will not support the float. The dropping of the float operates the automatic switch that cuts off the voltage. The float control is a safety device that is installed on all Petreco dehydrators to prevent the application of voltage to the electrodes before the shell is completely filled. This eliminates any possibility of a spark or an arc between the electrodes when the dehydrator is only partially full, and has a mixture of oil vapor and air above the oil.

The operation of the automatic float-controlled switch in the manner described, means that voltage will be applied to the electrodes intermittently with the result that only part of the oil going through the dehydrator will be subjected to the electric field. The water content of the oil discharged from the dehydrator will, therefore, be higher than necessary, because of a mixture with some untreated wet oil that has passed between the uncharged electrodes during the time gas in the float control apparatus caused the voltage to be cut off.

Gas Between Electrodes. A second effect is due to liberation of gas between the electrodes. When the dehydrator used is of the HF type there is a tendency to float the upper electrode. There are two conical electrodes in the HF type of dehydrator, and the wet crude enters at the center of the lower cone. The upper, which is the "live" electrode, is suspended from insulators, and is moved up and down, by a walking beam outside the dehydrator. When gas collects under this upper electrode faster than it can be relieved through the gas vent, it causes the electrode to float, that is, it will not drop the full length of the stroke, which will have the effect of too wide an electrode spacing. In some cases, more gas will collect under one side of the electrode than under the other, causing it to tip, which causes a wide spacing on one side and a narrow spacing on the other. The results will be poor dehydration due to improper electrode spacing, with correspondingly higher cuts over the top.

When a CF type electrode, which consists of a nozzle jetting the oil along a rod in the center of a small diameter shield (3 to 7-in. diameter), is used gassing also has been found detrimental. In this case, the gassing upsets the oil circulation around the shield, so that conditions for proper dehydration are not maintained between the central rod and outer shield. The results are again incompletely dehydrated oil.

Gas in Settling Space. Another effect of gas, irrespective of the type of electrode, is the rapid rising of the gas through the oil, which causes agitation in the upper part of the dehydrator. Excessive gassing and foaming also has a tendency to form new emulsions. The space above the electrodes should be maintained in as quiet a condition as possible to facilitate the settling of the coalesced water particles, and prevent them from being carried out of the dehydrator in the dry oil stream.

It is, therefore, apparent that gassing inside an electric dehydrator has a detrimental effect, and causes increased dehydrated oil cuts.

Elimination of Gas. There are two methods that can be easily applied in the field to eliminate the detrimental effects of gassing. The first is to reduce the temperature to a point where gas will not be formed in sufficient volume to affect dehydration, and the second is to apply sufficient pressure to keep the oil and gas in the liquid phase. The plants in the field should be operated at the lowest permissible temperatures at all times, since an increase in temperature above that necessary for efficient dehydration will only serve to increase costs. The first method of reducing gassing cannot often be applied, as satisfactory operation cannot be obtained if the temperature is too greatly reduced.

This leaves only one method of overcoming the difficulty, operating at as high a temperature as necessary, and increasing the pressure sufficiently to keep the gas from forming. This method has been applied to several plants with considerable success on both high and low gravity oils, over widely distributed fields.

Flat Bottom Shell. Unfortunately, sufficient pressure cannot be applied to all electric dehydrators in use in the fields. The first closed type electric dehydrator (the so-called flat bottom type shell), was designed in 1921, and at that time represented a distinct advance in the dehydration of crude oil emulsions. These dehydrator shells have flat bottoms and cone shaped roofs, and are not built to withstand a pressure greater than five lb. per sq. inch. These shells are equipped with a by-pass loop extending five ft. above the top of the dehydrator as a safety device, to prevent building up a pressure that would cause buckling of the top and bottom.

Pressure Shell. The later pressure type shells were built to withstand a working pressure of 25 lb. per sq. inch. These units are equipped with a safety valve that will open and relieve any pressure in excess of 25 pounds. On this type of equipment it is possible to apply sufficient pressure to aid dehydration. To date the maximum pressure found necessary at the electrodes is 22 pounds.

Frequently, the normal operating pressure is sufficient to prevent gassing inside the dehydrator. This is especially true where the dehydrated oil passes through heat exchangers, or a cooling tower before entering the stock tank. If it is necessary to increase the pressure above the normal operating pressure a spring-loaded relief valve is placed in the dehydrated oil line. This valve must be of such construction that it will hold approximately a constant pressure, irrespective of the volume of oil passing through. It is necessary to observe extreme caution in applying pressure so that it will not rise in excess of 25 lb. for which the shell was designed.

*Research Engineer, Petroleum Rectifying Co. of California.

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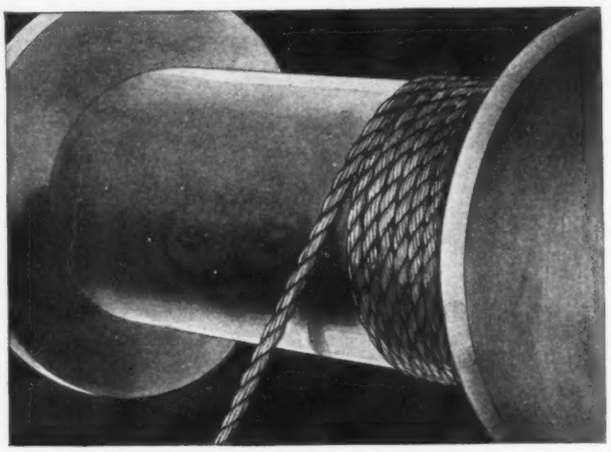
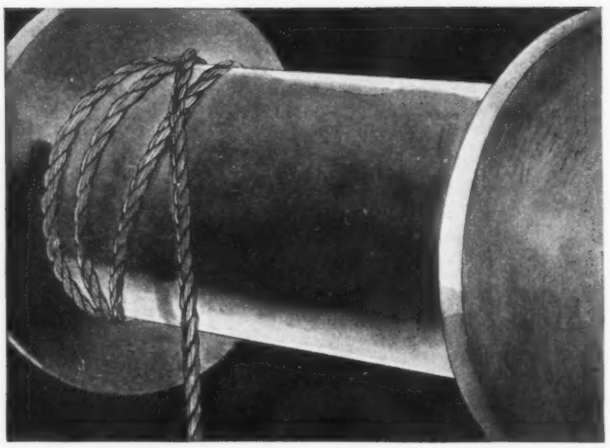
and it will always reel right



Start it wrong
and the positive result is early destruction



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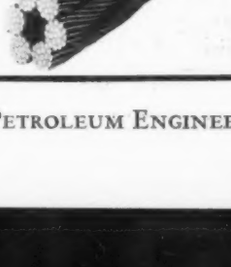

Engineering Fundamentals Department

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W. L. NELSON
K. C. SCLATER
Editors

Elements of Applied Production

By K. C. SCLATER

Article 6

Wells Produced by Mechanical Means

EQUIPMENT AND OPERATION OF OIL WELLS (Continued)

SWABBING AND BAILING. Oil wells may be produced by swabbing or by bailing. As an economical means of producing oil, however, either of these methods has a very limited application. They are usually employed only as an expedient. If large quantities of liquid are to be handled and the well does not produce gas, swabbing or bailing may sometimes be employed to advantage. But if gas is present in any quantity, swabbing or bailing is not recommended; being expedients, they are rarely economical or desirable as a production method.

It has been the practice in the past to produce a well by swabbing when large quantities of water have had to be lifted with the oil. Bailing has also been used as a method of production where very heavy oil was to be lifted—oil too heavy to pump or be flowed by gas-lift—or where sand in excessive quantity accompanied the oil. As a method of production, bailing has been widely used in the oil fields of Russia and Roumania, chiefly because of sand in the oil. Until a few years ago these seemed to be the only feasible production methods available to cope with such conditions.

In the light of our present-day knowledge of subsurface changes that occur in a reservoir as oil and gas are withdrawn, the adoption of swabbing or bailing as a regular producing method is seldom justifiable. Swabbing may, and usually will, hasten water encroachment in a well and cause water-coning, which may eventually shut off the flow of oil into the hole. On the other hand, though rarely, swabbing may be resorted to with success for removing water and preventing it from drowning out the oil in a well, or for keeping the water off surrounding wells. Its greatest application for this purpose is usually confined to limestone reservoirs.

Nowadays it is seldom necessary to resort to either swabbing or bailing, for other more desirable production methods are now available. The fact that they are occasionally employed, however, would seem to merit their brief description here.

Swabbing is carried on through the casing or through tubing of large diameter (four inches or greater). The swab may be run on a wire line or on a string of tubing, the former being the more common practice. When run on a wire line, the swab is attached to the drill stem. The wire line is usually operated from the bullwheels, if a standard cable tool rig is being used, or from a portable hoist.

Swabs. Although swabs are available in a variety of designs, they are all constructed on essentially similar principles. They are so designed as to allow the swab to drop down easily through the fluid. A hole through the body, provided with a check valve or similar device, permits the passage of fluid through the swab as it is lowered in the well. On being pulled up, the check valve or other device closes and the fluid (liquid) above the swab is brought to the surface.

Some swabs are equipped with some type of release by which, if too heavy a load has been taken, part of the load is released through the body of the swab. This is an important and a very desirable safeguard in swabbing wells that have a high fluid level.

The size of wire line used will depend upon the quantity of liquid to be handled, the diameter and depth of the well, and the prime mover or source of power available. The swab itself consists essentially of the swab rubbers mounted on a steel body equipped with some type of check valve. The rubber or rubbers may be specially moulded or be made from layers of heavy rubber-fabric belting, and are of various shapes depending on the design and make of swab. Rubbers vary in design from plain solid rubber sleeves, to rubber composition flexible cups with steel guide wires.

Bailers. Bailing as a method of producing oil has been more widely used in foreign countries than in the United States. The practice of running the bailer and dumping it at the surface had become a routine operation. In some cases the whole cycle of operation was made almost automatic. An interesting installation of this type was made in California several years ago in the Kern River oil field.[31] Like the swab, bailers when used for this purpose usually are run on a wire line from the bull wheels or from a portable hoist.

Oilsaver. An oilsaver, as its name indicates, is used to prevent the waste of oil. It is simply a stuffing box attached to the casing control head through which the wire line is run into the well and is made in two sections so it can be conveniently placed on the wire line. The packing in the stuffing box consists of specially moulded rubbers that are easily replaced when they become worn. Modern types of oilsavers, which are still widely used in cable-tool drilling operations, are equipped with hardened steel rollers for keeping the line in alignment when passing through the oilsaver, thus preventing undue wear and tear on the line and the oilsaver body and packing.

The oilsaver is held in place on top the control head by set screws, by loosening which the oilsaver is released when the swab is to be pulled out of the casing.

Hoisting Equipment. For heavy swabbing or bailing the average size of wire line used is from ¾ in. to ⅞ in. in diameter. On deep rotary wells, up-to-date hoisting equipment of the portable type is favored for swabbing and bailing. These hoists are equipped with various speeds and are well adapted to meet all well conditions. They are designed for continuous operation and to save time in making a round trip in and out of the well. They are available for use with prime movers of any type—steam or internal combustion engine, or electric motor, depending on what is most convenient and economical.

As the trend toward gas conservation and secondary recovery methods of production increases, swabbing or bailing as a production method will soon become obsolete.

GAS-LIFT. More than 30 years ago the air-lift was in use in the Gulf Coast fields for the production of oil. The gas-lift is an outgrowth of this development. It was during the development of the Seminole field that the possibilities of the gas-lift as a means of increasing the daily production of oil from a well were suddenly recognized. Avidly the method was seized upon to boost the daily oil yield of wells. This started overproduction and its attendant evils, resulting in the ills that still beset the industry.

Improvements in gas-lift practice since these Seminole days have increased rapidly. Its possibilities as a production method have increased in scope. No longer is it employed primarily to increase the daily rate of production; it has been developed into an effective means of conserving gas energy and for increasing the ultimate recovery of oil. This it does by supplying extra gas energy to raise the oil from the bottom of the well to the surface, and utilizing the available gas energy in the sand to force the oil into the hole. The flowing life of the well can be prolonged and ultimate lifting costs reduced by the judicious application of the gas-lift.

Many excellent papers[32, 33] have appeared on the principles of the gas-lift, a subject about which only a bare outline can be given here.

Although the principles of the air-lift and the gas-lift are the same, the practical application of the gas-lift is difficult because of the lack of essential data. How much gas is in solution in the oil, its composition and how it is associated with the oil at the bottom of the hole are among the important factors that should be known. The lack of reasonably accurate information of this kind is usually one of the chief difficulties that is met with at the outset.

When oil flows into the bottom of the hole of a well just drilled in, it is usually charged with gas. This gas will either be dissolved in the oil as a liquid or will exist as minute bubbles of free gas, or both, depending upon the pressure and temperature. Owing to the release of pressure as the oil comes into the hole, the gas expands and the minute bubbles become larger. Soon the liquid constituents of the gas begin to form minute gas bubbles. This causes the column of fluid in the well to lengthen, or, as would be said in the field, a rise in the fluid level. The expansion of the gas and the lengthening of the fluid column cause the latter to become lighter as it approaches the surface. Thus a column of fluid only a few feet long at the bottom of the well may become several hundred feet long by the time it reaches the surface. If the total weight of the column of fluid (oil and gas) is less than the pressure at the bottom of the well, natural flow will result. Whether or not the flow thus induced will be continuous will depend upon whether the oil and gas can come into the hole fast enough against the back-pressure established at the bottom of the hole (more accurately, the face of the oil sand) by the flow column.

Any variation between the flow of oil and flow of gas will change the weight or density of the fluid column. In general, it may be said that an increase in the proportion of gas will decrease the total weight of the fluid column in the well, and a decrease in the proportion of gas will increase the weight of the column. Such a decrease of gas may become great enough to increase the weight of the flow column so the weight of the latter is equal to the reservoir pressure —that is, the reservoir pressure in the vicinity of the well. When this happens, the well has ceased to flow; it is said to have "loaded up" or to have "died." It is by virtue of the gas in the oil that the weight of the fluid column in a well is lightened and the well induced to flow. Osgood,[34] in describing the gas-lift states: " * * * a well partly filled with fluid and having two pipe lines extending down into the fluid. Assuming that one cu. ft. of compressed gas enters a flow line 1000 ft. below the surface of the fluid, it will be under a pressure of approximately 400 lb. per sq. in. and will occupy only about one-twenty-seventh the space it occupied before compression. For ease of illustration, assume that the cross-section area of the flow line is one sq. ft. or, in other words, that each lineal foot of the flow line will contain one cu. ft. of either gas or fluid. Then the fluid level will be raised one ft. by the mere entrance of one cu. ft. of gas. When the gas has in its upward course almost reached the top of the fluid, it will have expanded to a volume of almost 27 cu. ft. and will have raised the fluid level 27 ft. within the flow line.

"If no more gas enters from the bottom of the gas pipe, the bubbles of gas will simply burst and the fluid level will fall down 27 ft. to its original level. If more gas is forced in immediately after the first cubic foot has started upward, however, each subsequent cubic foot will behave the same as the one rising above it and each bubble by expanding will still further raise the fluid level in the tubing. The total effect of all these rising gas bubbles will amount, practically, to a stretching of the column of fluid upward and making it a long or high column of mixed gas and fluid having the same weight as the original short column of undiluted fluid. This apparent stretching of the column and raising of the fluid level within the tubing will have no effect upon the fluid at the bottom of the tubing or at any point outside the tubing, because the column inside has not changed in weight.

"In a naturally flowing well, the oil is fed into the bottom of the hole by means of the gas pressure and there are sufficient volume and pressure of gas to make a natural gas lift from the bottom of the well to the surface, but when the volume or pressure of the gas becomes insufficient, then it is necessary to add additional quantities of gas or air from the surface."

This is the simple principle upon which the gas-lift operates. A thorough grasp of it is essential in order to understand the efficient application of the gas-lift.

In a gas-lift well, as the term gas-lift is used here, gas (or air), usually from a source outside the well, is supplied from the surface to assist in inducing flow. Gas may be injected continuously or intermittently, depending on the gas-lift system in use.

It is not enough to know the existing conditions in a well

in order to equip it for gas-lift; how conditions in the well are likely to change should also be known. To determine the latter may involve a study of subsurface conditions, such as the rate of decline in reservoir pressure; how this decline is related to the withdrawal of oil and gas from the pool; the proportionate decline between gas and oil production; the presence of water and in what amount it should be produced.

When all the information available regarding the possibilities of the well as a producer has been gathered it is necessary to determine whether the gas-lift will be economical. Certain conditions may enter to give great weight to the use of the gas-lift. A deep well the hole of which is crooked, or the handling of large quantities of water, may be the governing factor. On the other hand, the tendency of the oil to form a refractory emulsion may preclude its use. Gasoline extraction may also enter and be a governing factor quite regardless of well conditions. These are all items that must be given due consideration.

When the principle of the gas-lift was outlined it was observed that a lack of gas in the flow column may cause a well to "load up" and stop flowing. This is what actually happens to a flowing well when it nears the end of its naturally flowing life. Injecting a small volume of gas continuously into the lower end of the tubing or flow column may be all that is required to keep the well flowing for several months longer. There comes a time, however, when a tubing string must be designed if the well is to continue to flow by gas-lift. The tubing string should be designed from reliable well flow data.

Tubing Arrangement. Methods of flowing gas-lift wells vary. Some are flowed through the tubing and others between the tubing and the casing. Sometimes both methods are tried in a well. When "cut-and-try" methods are used the fault usually lies in designing the string on inaccurate well data rather than in unforeseen changes in the well conditions having had to be met.

Two types of tubing string are used in the gas-lift, the straight string and the tapered string. The latter is tapered upward and its use based on the theory that by increasing the cross-section of the tubing area upward allowance can be made for the increased volume due to gas expansion and the velocity, and hence the friction, in the flow column kept within desirable limits.

There are certain terms used in gas-lift work with which the field man should become familiar. The distance from the casinghead down to the water level is known as the lift, or pumping head; the distance from the fluid level down to the point at which the gas is injected into the fluid column or tubing is known as the submergence; and the depth in feet of submergence divided by the sum of the height in feet of lift and the depth in feet of submergence, is known as the percentage of submergence. Submergence plays an important part in gas-lift work and will be discussed presently.

When oil is lifted through tubing, there are three energy-consuming sources: (1) the energy consumed in lifting the oil and gas to the surface, (2) the energy consumed by friction between the wall of the tubing and the fluid, (3) the energy consumed by slippage in the flow column. Only two of these, friction and slippage, are subject to control by proper mechanical design and operation. It is with the reduction of friction and slippage that the design of tubing strings is chiefly concerned. To gas-lift the fluid from the well within the range of rates at which it is desired to produce with the minimum loss of energy from friction and slippage, is the purpose of designing a tubing string. Although this purpose is aimed at, it is seldom attained; the flowing range may be too great or the well conditions unfavorable. Accurate data on the behavior of oil, gas and water mixtures in vertical flow columns under the conditions found in a flowing well are still inadequate. Despite these drawbacks reasonably close approximations may be made in designing an efficient tubing string.

There are certain essential conditions, which if not present, preclude the use of the gas-lift. One of these is submergence. The fluid level should be sufficient to permit a working submergence of at least 16 per cent on the average well. For example, in a well 2000 ft. deep, with the tubing only a few feet off bottom, the fluid level, while the well is being flowed by gas-lift, should be at least 16 per cent of 2000 ft. from the bottom of the well, or 320 ft. above the lower end of the tubing.

Several approximate methods of designing tubing strings will be taken up in the next article.

QUESTIONS

1. On what type of well and under what conditions might it be advantageous to:
   (a) Swab a well as a routine production method?
   (b) Bail a well as a routine production method?
2. Explain briefly the principle upon which the gas-lift operates in an oil well?
3. What conditions favor the use of the gas-lift?
4. What is meant by:
   (a) Submergence?
   (b) Working submergence?
5. In what three ways is power consumed in a gas-lift well?
6. What should be the objective in designing a tubing string for a gas-lift well?

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Joseph A. O'Brien Dies

Joseph A. O'Brien, production superintendent for the Carter Oil Company in southern Oklahoma, died early this month at Healdton, Oklahoma. He was taken ill while on a tour of his company's properties.

Mr. O'Brien was 53 years of age, being born at Summit City, Pennsylvania, in 1881. His first job in the oil industry was with the Eureka Pipe Line Company at the age of 16. A few years later he became an independent producer and later joined the South Penn Oil Company in West Virginia. In 1906 he went to Rumania with the Romano Americano Oil Company, a subsidiary of the Standard, where he remained until the early part of 1917. He returned to America to work for the Carter Oil Company, making his headquarters in Tulsa, until January, 1919. At that time he returned to Rumania where he remained until 1925. Since then he has been with the Carter in Kansas and Oklahoma.

New International Stores

The International Supply Company, Tulsa, Oklahoma, announces the opening of new stores at Fairfax, Oklahoma, Chase, Kansas, and Houston, Texas. E. H. Raymond is store manager at Fairfax and Ted Wimmer, formerly with the Oil Well Supply Company, is field salesman. At Chase, Bob Aldrich, formerly with the Drillers Supply Company, is store manager and John Rice, formerly with the Walter O'Bannon Company, field salesman. William Ussery is store manager at Houston, James Mayfield field salesman and E. C. Kirby city salesman.

The company also announces the establishment of a branch office in Dallas, Texas, with J. R. McCrea, formerly district manager of the A. O. Smith Corporation, in charge.

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THE NATIONAL SUPPLY COMPANIES

Elements of Applied Petroleum Refining

By W. L. NELSON
Professor of Petroleum Refining,
University of Tulsa

Article VI

FLOW DIAGRAMS, OPERATING DATA AND DISCUSSION
(Continued)

CRACKING OPERATIONS. Since about 1910 the demand for gasoline has increased so rapidly that the refiner has had difficulty in supplying the demand. The increase was partly met by the production of more crude oil but this was not a satisfactory solution because the part of the crude oil that remained after removing the gasoline could not be disposed of profitably. The cracking processes were developed to dispose of these excess heavy stocks and to produce gasoline from them. By cracking it is possible to produce from 50 to even 75 per cent of gasoline from crude oil. In addition to the demand for a large amount of gasoline, the modern high-compression automotive engine has created a demand for an anti-knock gasoline. This demand has also been met by the cracking processes because the gasoline that is produced by cracking as in anti-knock gasoline. During the last two years the demand for anti-knock gasoline has become so great that so-called reforming processes have been developed. In reality these are nothing more than cracking processes in which naphthas or even straight-run gasoline is used as the cracking stock. Straight-run gasoline knocks badly in modern engines but, after reforming it by a short cracking operation, it may be more highly anti-knock than ordinary cracked gasoline.

Definition of Cracking. When an oil is heated to temperatures exceeding about 700 deg. fahr. it decomposes, yielding an oil that boils at a lower temperature. The operation may be illustrated by the following chemical reactions:

Charge stock - - C-C-C-C-C-C-C-C-C-C-C-C-C-C-C
(gas oil)

Cracked stock C-C-C-C-C-C=C and C-C-C-C-C-C-C-C
(gasoline) (gasoline)

Overcracked - C-C-C and C=C-C=C and C-C-C=C
(gas) (gum or tar) (gasoline)
and C-C-C-C.
(gasoline)

These reactions are decomposition reactions. The third reaction labeled "overcracked" is not entirely desirable but it cannot be avoided. Overcracking cannot be avoided because a number of chemical compounds are found in the charge stock. What may be the proper conditions for the cracking of most of the compounds may cause overcracking of others.

In addition to the above decomposition reactions, others, which are termed secondary reactions, take place. The gum- and tar-forming substances combine with themselves and produce materials that may have as many or more carbon atoms in them than the original stock has. If combination continues to take place, coke is produced instead of tar.

Thus the products of cracking are gas and gasoline by decomposition and tar or coke by combination reactions.

TYPICAL FLOW DIAGRAMS AND OPERATING DATA
(Continued)

Cracking Processing and Distillation Processing. In many respects cracking processing is similar to distillation. In both the charge stocks must be heated, the mixture of materials must be separated by fractionation and the products must be cooled and condensed. In other respects the two processes are different. During distillation the materials that compose the charge stock are separated but they are not otherwise changed. During cracking the charge stock is decomposed into new materials.

The rate at which cracking takes place is nearly directly proportional to the time that the material is heated. In other words, if the yield is ten per cent when an oil is heated for 100 seconds the yield after 200 seconds will be about 20 per cent. The effect of the temperature is even more important. In liquid phase cracking the rate doubles for each 20 degrees rise in temperature. Thus, if the yield is six per cent in 100 seconds at 800 deg. fahr., the yield in 100 seconds at 820 deg. fahr. is about 12 per cent and at 840 deg. fahr. 24 per cent.

Yields of 40 per cent in a single heating are not economical because the combination reactions that were referred to above tend to take place. At such yields, a part of the gasoline combines with itself to produce tar or coke so that smaller yields are obtained and, furthermore, the operation may be halted by the formation of coke. For this reason cracking is always practiced commercially by producing only a small yield in a single cracking operation. The tar that is produced in the mild cracking reaction is separated by fractionation. In this distillation operation, tar is separated, gas and gasoline are separated and an intermediate stock called recycle stock remains. The recycle stock is then cracked again but the yield is never greater than about 20 per cent for each cracking operation. By cracking the recycle stock over and over again it is all eventually disposed of as gas, gasoline or tar. In commercial operation the cracking of the fresh stock and the recycle stocks is carried on simultaneously in a single pipestill. Refer to Fig. 16. In other words, a mixture of fresh stock and recycle stock is fed continuously to the pipestill.

If more than about 20 per cent of cracking is practiced per cycle, coke will be deposited in the heating tubes. At the same time the rate of heating should be low or coke will be deposited. This may be accomplished by the use of a large amount of surface in the pipestill, the use of flue gas recirculation or the use of large amounts of excess air. All these methods tend to reduce the temperature in the furnace. Stocks that contain tar cannot be cracked without depositing coke. If such stocks are processed in a cracking plant there is either a provision for the accumulation of coke or the tarry stock is distilled and only the distillate is subjected to cracking.

The effect of pressure upon cracking is largely indirect. At cracking temperatures (700-1200 deg. fahr.) all cracking stocks are partly vaporized. But mixtures of oil and vapor cannot be easily cracked because the liquid wets the walls of the tube or vessel that is being heated and is overcracked. Thus cracking is practiced either at a high pressure (400-1200 lb. per sq. in.) in the liquid phase or at a low pressure (25-50 lb. per sq. in.) in the vapor phase. It is important that the material that is cracked shall be either a liquid or a gas and not a partially vaporized mixture.

Processing. In general the many commercial cracking processes are essentially the same. The differences are mainly in the kind and arrangement of the equipment that is used rather than in the method of processing. Fig. 16 illustrates the essential features of a cracking system in which coke is not produced. A small amount of coke is produced in the tubes and in the base of the evaporator but it is not purposely produced. Plants that embody these features can be operated from 30 to 90 days if they are properly designed and operated.

All experts on cracking now agree that the stock that is cracked should be a distilled stock and one that is free from tar and they agree that the cracked material that flows from the pipestill at a high temperature, should be quickly cooled by means of a so-called quench stock. A clean distilled stock is necessary if coke is to be avoided and the quench stock is required to cool the cracked material and halt decomposition before coke is produced.

The route of flow can be followed in Fig. 16. The charge stock is a topped or reduced crude oil. It is heated by heat exchangers and another heater to a temperature of about 700 deg. fahrenheit. The hot stock that flows from the outlet of the cracking still (D) is quenched (A) with the reduced crude oil and the mixture enters the evaporator (B). The temperature is sufficiently high in the evaporator to distill the gas oil from the reduced crude and to vaporize all the pressure distillate and recycle that is contained in the hot cracked stock. The vapor, gas oil, gas, gasoline and recycle pass into the fractionating tower (C) and tar or cracked fuel oil remains in the evaporator. The gas oil or recycle stock is collected in the bottom of the fractionating tower and this mixture constitutes the charge stock to the cracking still (D).

Liquid phase processes operate at pipestill outlet temperatures of 880 to 960 deg. fahr., depending upon the charging stock, and at pressures of 400 to 1200 lb. per sq. inch. Vapor phase processes operate at higher temperatures because the time that the vapors remain in the still is necessarily short. Vapor phase processes operate at temperatures of 1050 to 1250 deg. fahr., and at pressures of about 35 lb. per sq. inch. Higher temperatures are required to crack fuel oil and heavy gas oil than to crack kerosene or naphtha. Hence, the temperature used in reforming processes is high. Temperatures of 975 to 1100 deg. fahr. are used in reforming plants.

Pressure Distillate. The distillate (raw gasoline) from a cracking process is a dark or yellow-colored material, which is unstable. Upon standing or exposure to light gum-like solid materials are deposited and the color becomes even darker. Pressure distillate usually has a foul smell and it may contain high percentages of sulphur.

The distillate must be treated in order to produce a material that is sweet smelling, non-corrosive and stable with regard to color and the formation of gum. Treatment with sulphuric acid followed by a sweetening treatment is the most common method of refining pressure distillate. The operation consists of: (1) contacting the distillate with acid, (2) washing with water, (3) contacting with doctor solution, and (4) washing with water. From 0.75 to 6 lb. of 60-Bé acid is required per bbl. of distillate. The acid removes the gum and improves the color and the doctor treatment improves the odor and removes sulphur. The details of treating processes will be discussed in subsequent articles.

If the distillate does not contain harmful quantities of sulphur, the vapor phase treating process may be advantageously used. In this method of treatment the distillate vapors are conducted through a tower, which is packed with fuller's earth. After passing through the earth, the vapors are condensed and cooled. No further treatment is necessary. The gum-forming materials combine with themselves during passage through the earth and collect in the bottom of the clay tower as so-called polymer-liquid. Vapor phase treating is highly successful with certain distillates but it cannot be used if the distillate contains sulphur.

If the distillate is to be acid-treated and redistilled it should consist of 70 to 90 per cent of gasoline. The residue of 10 to 30 per cent is necessary so that a bottoms material (P.D.

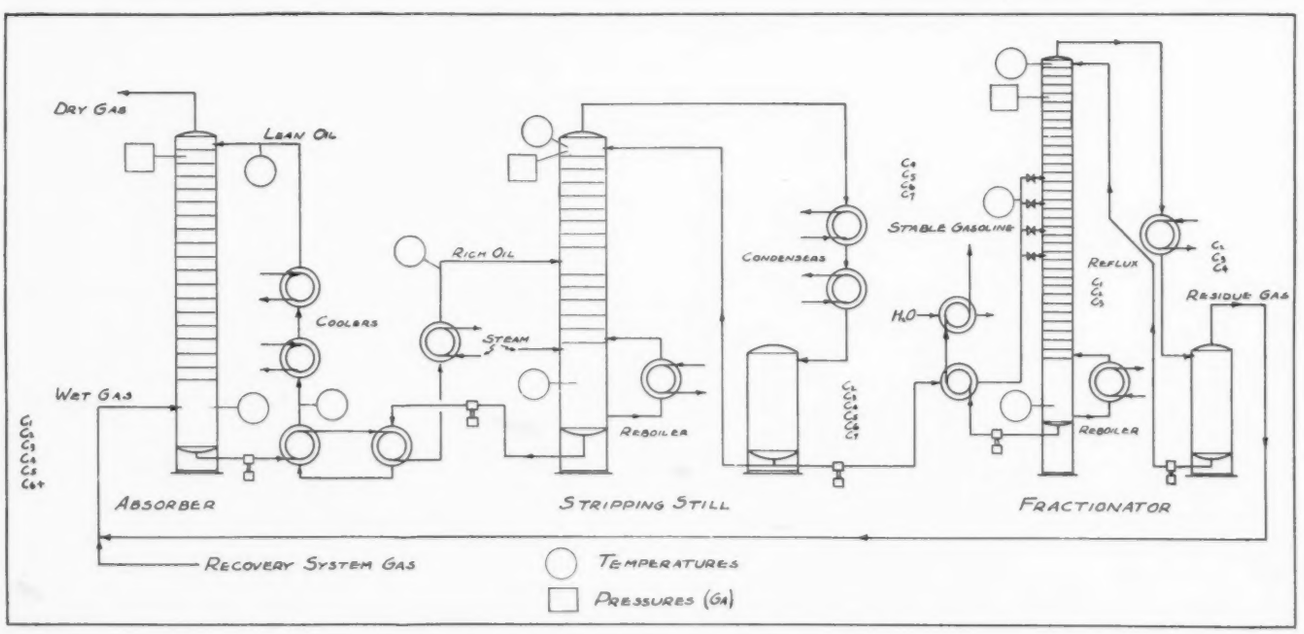

Fig. 15. Absorber, Stripper and Fractionator

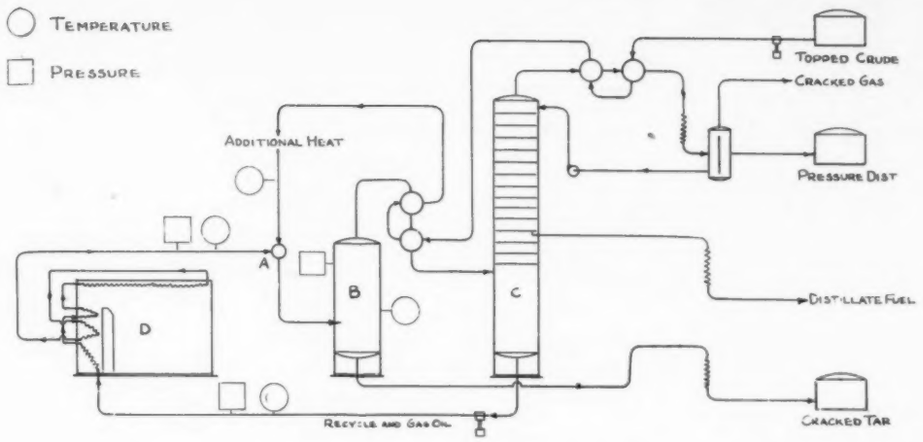

Fig. 16. Flow diagram of a cracking plant

butts) will be available for the redistillation. If the vapor phase treating process is used the pressure distillate is made to end-point in the cracking unit.

Rerunning Pressure Distillate. After the acid-treating operation as outlined above, the pressure distillate is a bright yellow color and is still unstable. The distillate must be distilled in order to produce a finished gasoline. After acid treatment the coloring materials and most of the gum-forming materials are found in the highest-boiling part of the distillate. But the distillate is sensitive to heat. The coloring matter decomposes at temperatures exceeding 375 deg. fahrenheit.

The distillation must be conducted at low temperatures in order to avoid discoloration. Most refiners limit the temperature during redistillation to 325 deg. fahr., and others limit the temperature to 275 deg. fahrenheit. While the recorded oil temperature is only 325 or 275 deg. fahr., the film of oil that exists on the walls of the pipestill tubes or the walls of a shell still may be at a temperature above 375 degrees.

If all the heating is done with steam (no furnace) a high film temperature cannot exist and temperatures of 350 deg. fahr. can be safely used.

Steam is commonly used to reduce the temperature but some refiners have installed vacuum plants. These vacuum plants operate at pressures of 90 to 200 mm. Lower pressures are not practical because the distillate cannot be condensed unless the cooling water is at a very low temperature.

Distilling at a low temperature is expensive, but the cost of acid treatment is greatly reduced if the distilling temperature is low. In addition, the gasoline is usually more stable. Thus the amount of acid that is required is large if the distillation temperature is high, and vice versa.

Fig. 17 shows a modern large-capacity pressure distillate rerun plant in which steam is used to reduce the temperature. If only a small amount of distillate is produced, a shell with a fractionating tower is more commonly used. It will be noted that there is nothing unusual about the distillation system used in Fig. 17.

The use of a steam superheater as shown in Fig. 17 is not peculiar to the processing of pressure distillate. Such a steam superheater may be used in any distillation operation. It is an advantage because it serves to perfect the first rows of tubes in the convection section and also it assures that large slugs of water will not be delivered to the hot fractionating tower.

QUESTIONS

1. The aim of cracking is the production of gasoline. Why are gas and tar also produced?
2. What factors affect the rate at which cracking occurs?
3. Why is the cracking per cycle limited to about 20 per cent?
4. Since the crack per pass is limited to 20 per cent, how are total yields of 50 per cent obtained by cracking?
5. Would a lubricating oil stock or a kerosene require a higher cracking temperature?
6. What is the major difference in the operating conditions for a liquid phase and a vapor phase cracking process?
7. Why is a clean distilled cracking stock desirable?
8. What two methods are used to keep the distillation temperature of pressure distillate to a maximum of 325 deg. fahrenheit?

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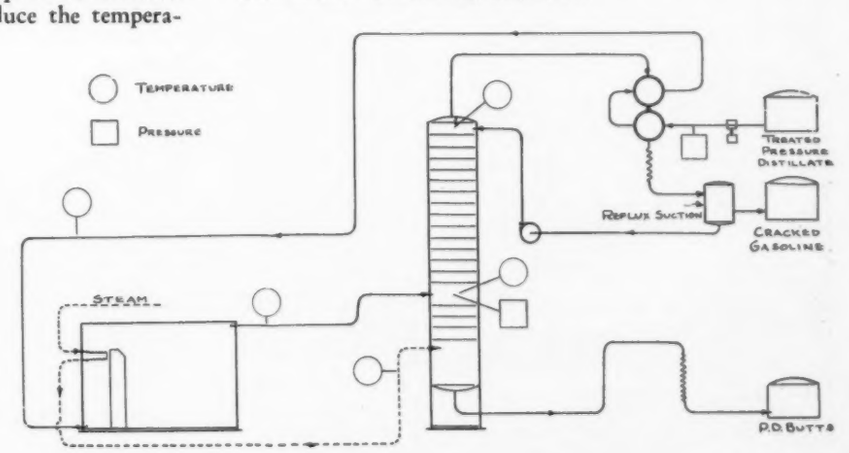

Fig. 17. Flow diagram of pressure distillate rerun plant

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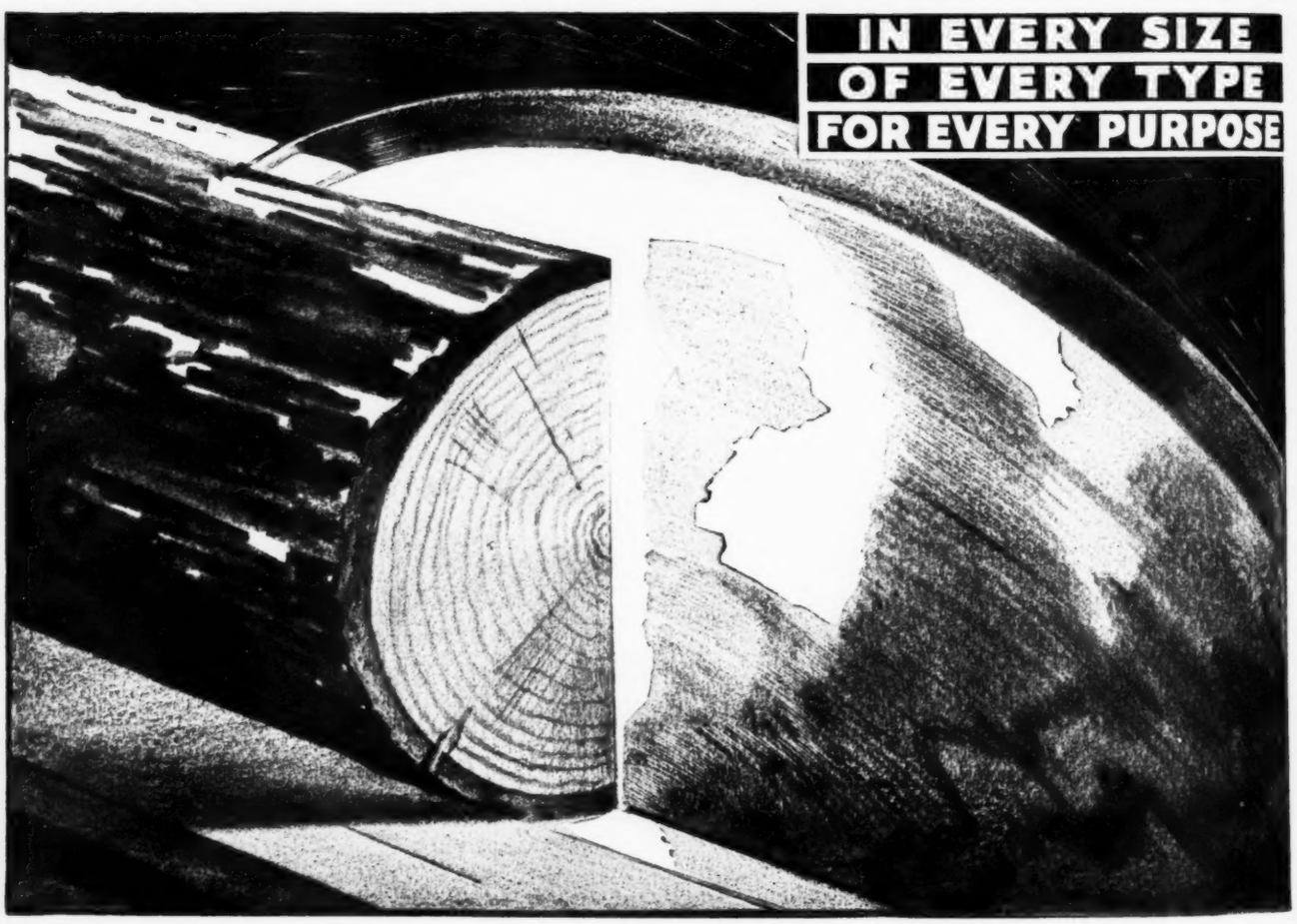
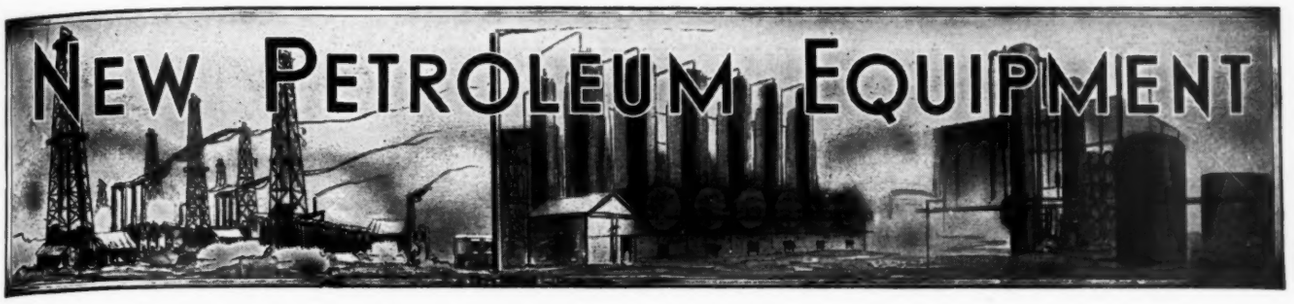
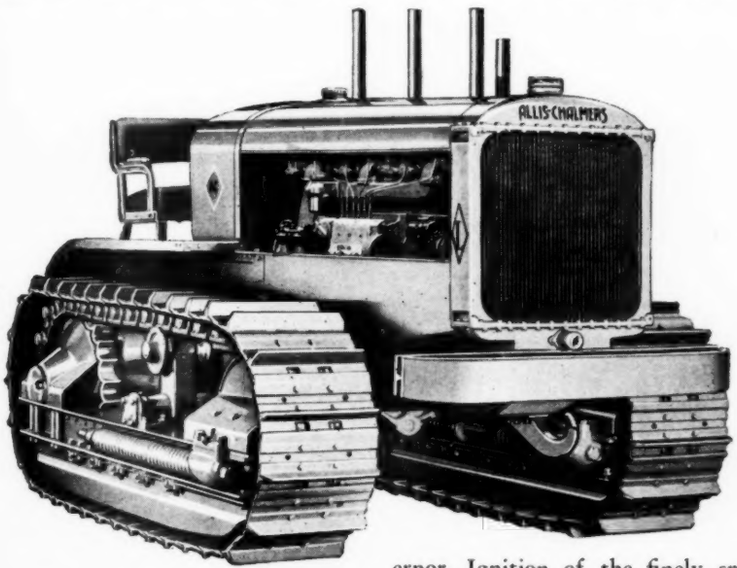




Allis-Chalmers Oil Tractors

THE Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announces the new "KO" and "LO" oil engine tractors, culminating more than ten years of research work, carried on in an effort to produce an engine to burn cheaper grades of distillate fuel oil. These models burn any grade of commercial Diesel fuel within the limits of viscosity, free from sulphur, and clean. The fuels from which greatest efficiency will be obtained are commercial Diesel oils, grades two and three. The engines start by either hand cranking or electric starter. This is possible because of the low compression of the engine (125 pounds), no special starter or auxiliary engines being necessary.

Fuel oil is injected into the cylinders under pressure through the Bosch Diesel fuel pump and injectors. The injection is positive and controlled by a governor. Ignition of the finely sprayed fuel oil is from a spark plug and magneto.



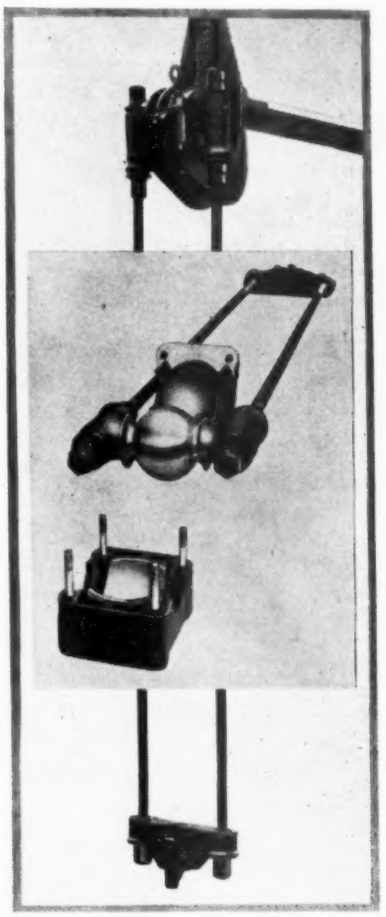
Weights of the "LO" and "KO" are 23,000 pounds and 11,200 pounds, respectively. "LO" standard is equipped with front bumper, pull hook and 20-in. track shoes.

Lufkin Improved Swing

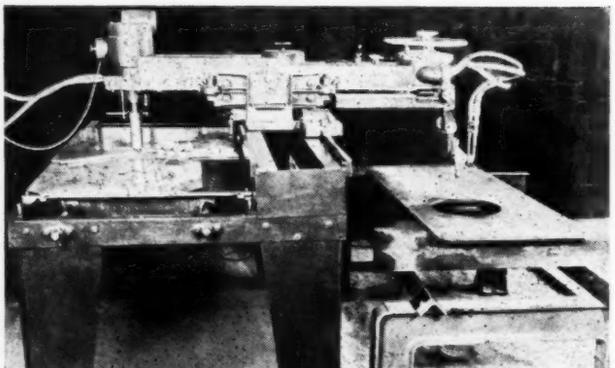
WITH the central shaft moving in an oil-tight, dust-proof bearing set in concrete this swing, manufactured by the Lufkin Foundry and Machine Company, Lufkin, Texas, avoids use of braces and practically eliminates wear, as the shaft floats in oil. Rod line bearings are Alemite lubricated. Wearing parts are easily and cheaply renewable. The oil-tightness feature will, in the opinion of the manufacturer, prove especially popular with those who take pride in a clean lease.

Beam Hanger—Type 20

THE Type 20 beam hanger produced by Lee C. Moore & Co., of Tulsa and Pittsburgh, has a projected bearing area of 34½ sq. in. and a capacity of 20,000 pounds. The oil bath bearing is constructed in such a way that perfect lubrication is assured, the manufacturers state. It is composed of a ball which fits into a babbitted socket in the lower half of the bearing assembly. This socket rests snugly in an oil reservoir. Perfect alignment is maintained by the cap which fits over the ball, holding it in position. The remainder of the parts are of cast steel, except the rods, which are furnished in 1½- or 2-in. diameter hot rolled stock.



Oxweld Pantosec Cutting Machine



As an addition to the Oxweld line of welding and cutting apparatus, The Linde Air Products Company, 30 East Forty-Second Street, New York, has introduced a new stationary cutting machine, of great versatility, known as the Pantosec. Being a precision shape-cutting instrument, it is especially suitable for cutting dies, cams, and other parts that must be smoothly and accurately cut. With a cutting range of 44 in. longitudinally and 20 in. laterally, it does straight-line cutting, angle cutting, beveling, circle-cutting and intricate shape-cutting. It requires a floor space of only 72 by 83 inches.

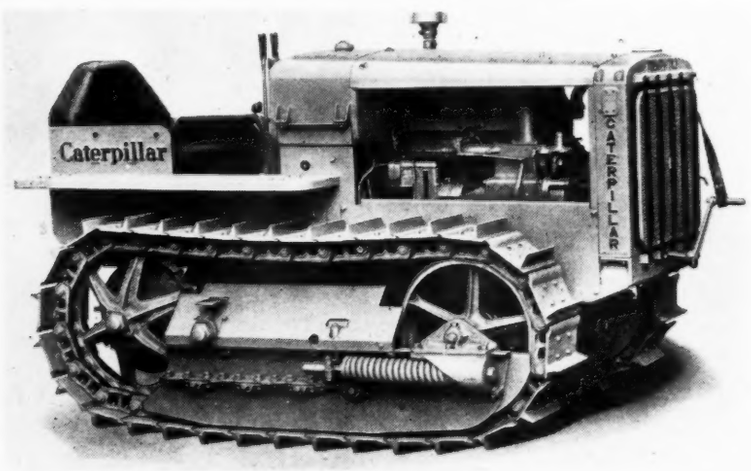
The Pantosec can be operated with a minimum of attention from either the templet or blowpipe end, as a hand-guided or machine-guided instrument, its manufacturers state. Angles can be cut without templets, since the cutting head can be locked for travel in any direction. Bevel-cutting is simplified, the provisions for adjusting the machine make it possible to line up the blowpipe without shifting the work, and the dividing head enables the operator to set stops on work that is to be cut in several directions. An extension so mounted as to be always steady and secure, makes it unnecessary for the operator to return to the back to start the profile cutting after the entry cut has been made.

The machine consists of a carriage mounted on three-point supports. The piping for the gases is enclosed in the carriage, and all drives are protected by dirt-proof casings. The motor may be specified when ordering to run on either 110- or 220-volt current. All wiring is concealed, and the switches and controls are clearly labeled and easily accessible.

Though the range of the Pantosec does not include large-scale cutting, it is adequate for all ordinary work.

"Caterpillar" Twenty-Two Tractor Announced

The triple economy of low first cost, operation on inexpensive fuels and the power savings of track-type traction are among the features of the new "Caterpillar" Twenty-Two Tractor, according to an announcement recently issued by Caterpillar Tractor Company of Peoria, Illinois.



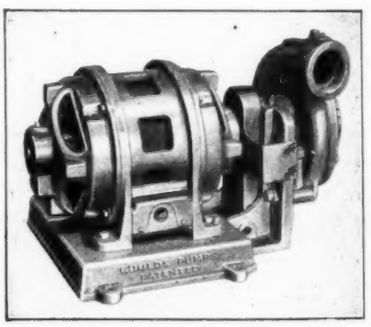
The new model is powered with a four-cylinder, four-cycle, valve-in-head engine developed especially for converting a wide range of low volatility fuels into efficient, dependable tractor performance. The engine has a 4-in. bore and 5-in. stroke and develops a maximum hp. of 23.69 at the drawbar and 28.39 on the belt at governed speed of 1250 r.p.m. Lubrication is force feed to all main, connecting rod and rocker arm bearings. A twin fuel tank holds 20 gal. of tractor fuel and 2 gal. of gasoline, which is used in starting, and a three-way fuel control valve is located on the dash in easy reach of the operator.

The fuel and cooling systems, manifolds and cylinder head have all been designed to give uniform, high-operating efficiency in handling low cost fuels. The carburetor is located directly beneath the heated manifold jacket and a heat exchange valve is provided to insure thorough vaporization of the fuel before it enters the cylinder. Water circulation is controlled with a thermostat and a radiator by-pass allows the engine to warm up rapidly. The new Eisemann magneto, with which the tractor is equipped, is of the stationary winding inductor type, which requires no lubrication.

The "Twenty-Two" is available in either standard or wide gauge models. The standard machine has a shipping weight of 6,150 pounds.

Motor-Centrifugal Pumping Unit

According to company engineers, compactness, high efficiency and low cost have been combined in the motor-centrifugal pumping unit recently announced by Goulds Pumps, Inc., Seneca Falls, New York. A new close-coupled type of mounting is used that permits the use of standard motors without special bedplates and brackets. The pump bedplate extends under the motor, relieving the motor of excessive strains.



These pumps are built in sizes ranging from ¾ in. to 4 in., and for capacities up to 1000 gal. per minute. Heads range from 10 ft. to 290 feet. A complete description, with comprehensive selection chart for both 1750 and 3550 r.p.m. speeds, is given in Goulds new Bulletin 204, sent on request.

The applications of these new pumps to the petroleum industry are many and varied.

Mercury-Switch Thermometer Controller

THE use of mercury switches to eliminate open make-and-break contacts controlled by the pen arm, is a revolutionary feature of a new automatic control thermometer announced by The Brown Instrument Company of Philadelphia, Pa. In this new controller, every six seconds a motor-driven control table determines the location of the pen on the chart in reference to the control setting, and tilts the mercury switch from one side to the other if the temperature has changed.

With this unique system, the measuring mechanism is free to position itself, unhampered by the control mechanism. There is no excess weight on the pen, no distortion of the pen arm, no restriction of pen movement. The making of control contacts is not dependent upon friction, because the switch is positioned with a positive action by the electric motor. Contacts are unaffected by vibration because the mercury switch is mechanically locked in place until a different position is required. Corrosion and dirty contacts are eliminated as the switch is sealed in glass. These mercury switches have capacities up to 15 amperes at 100 volts (10 amperes at 220 volts), thus eliminating external relays in most applications.

This control mechanism is adaptable to one-, two-, or three-contact control (or signalling) systems. In a two-record controller, each control mechanism can regulate a separate device, each may be used independently of the other, and each has its own control index.

This new Brown controller is also supplied as a time-temperature cycle controller. A transparent cam placed over the chart is used to shift the control index in relation to time. As the cam rotates with the chart, the control point is moved to new positions, depending upon the shape of the cam. A different cycle can be obtained by simply cutting a new cam.

All models of this controller are furnished in circular 10-in. or 14-in. dust-proof cases, and offer all the outstanding features of the new Brown recording thermometer and pressure gauge, introduced two months ago. For example, the measuring mechanisms are rugged and powerful; electric chart drive is standard at no extra cost; cases are back or bottom connected and interchangeable for flush, front-of-board or wall mounting.

Improved Chain Hoist Chain Hoist

ANNOUNCEMENT of an improved chain hoist is made by the Wright Manufacturing Division of the American Chain Company, Inc., York, Pennsylvania. Improvements have been made in the previous model to increase its durability, efficiency and usefulness. One innovation is zinc coating of all exposed parts, making the hoist practical for outdoor use and for service in moist and other corrosive atmospheres. The addition of precision ball bearings with integral grease seals supporting all moving parts, increases its efficiency. Wear is reduced to a minimum on all vital moving parts by a system of continuous lubrication of the positively sealed precision bearings. Additional minor improvements include hardened pawl tip, improved load chain guard and ball spring covers on oil tubes.

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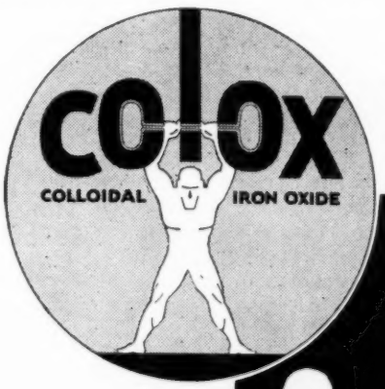

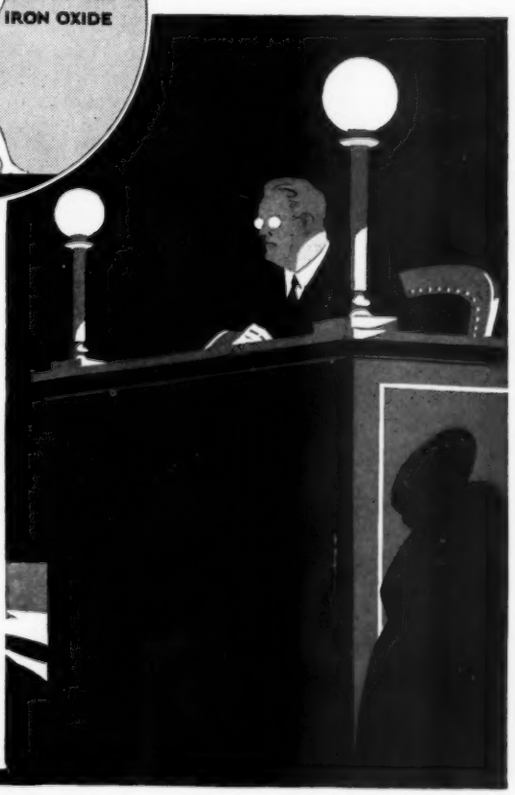

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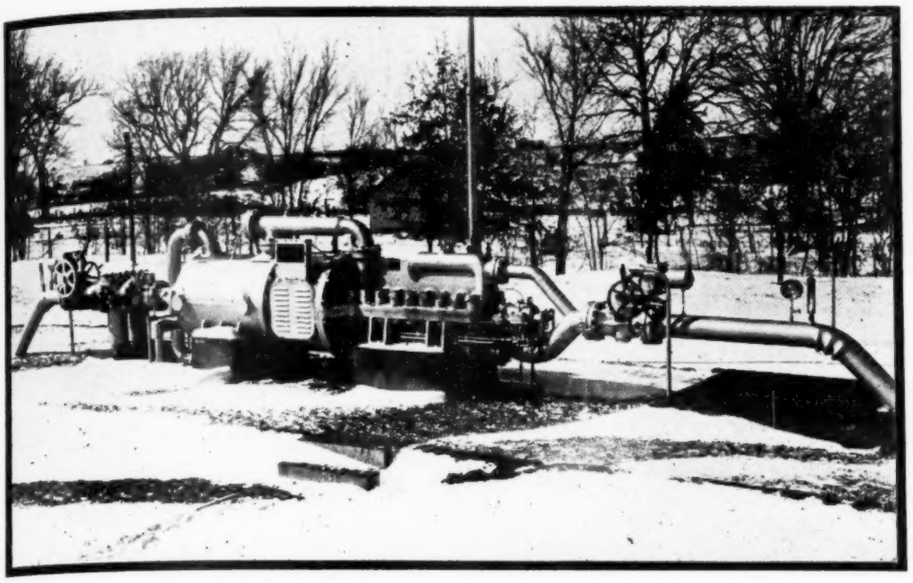


A Rannett pump, the type installed by the Great Lakes Pipe Line Company at Afton and Macedonia, Iowa

New Rannett Stations Added to Great Lakes Line

By FRANK H. LOVE

SINCE the completion of its line two and a half years ago, the Great Lakes Pipe Line Company has adhered to a program of steady expansion. As a part of this program, secondary stations of the Rannett type have just been put into operation at Afton and Macedonia, Iowa, on the 4-in. Omaha branch of the system. These are 200-hp. units, being the first of that size to be installed on the line. Previous Rannett installations were of 700 and 400-hp. To conform with the increased line capacity effected by these two new stations, additional pumping units have been installed in the primary plants at Osceola and Corning, Iowa.

Early in 1933 the Great Lakes organization constructed intermediate or secondary stations between each of its primary units, these being fifteen in number, thirteen of which were of the Rannett type. The stations were located at Copan, Oklahoma; Thayer, Selma and Bonita, Kansas; Paradise, Missouri; Lamoni, Indianola, Prairie City, Guernsey and West Branch, Iowa; and Cordova, Eldena and Elburn, Illinois. The success of the operation of these units was responsible for Great Lakes officials selecting them for the new Macedonia and Afton stations.

Development of the Rannett pump has been viewed by pipe line engineers as a radical departure in pumping station design and equipment. Constructed for erection in the open, the unit ordinarily requires no housing. The Great Lakes Pipe Line Company has made provision for covering in the northern climates, should extremely severe weather conditions arise. To date, the covering never has been employed.

In addition to designing a unit dust and weather-proof, to be used in the open, its inventors, Dan J. Moran, President, and E. O. Bennett, Chief Engineer, of the Continental Oil Company, have developed one that requires virtually no foundation, can be assembled at the manufacturing plant and moved to the final location ready for operation (installation necessitating but a few hours' time). It also is cooled by the fluid being pumped and has a motor for cross-line starting, thus eliminating an electrical switch gear.

The unit consists of either a 700-hp., 400-hp. or 200-hp., three-phase, two-pole, 2300-volt, 3600 r.p.m. induction motor direct-connected to an 8-stage centrifugal pump. Motor and pump are connected through a central spacer section to prevent deflection from external forces. The motor has its stator laminations inserted in a double-walled housing, the inner housing being seamless and constructed from a pierced forged steel billet, while the outer housing is of heavy welded sheets. End plates and bearings of the motor are carried by bolts against the double-walled stator housing in such a manner that the rotor and bearings can be removed without opening the space between the double shell.

The gasoline being pumped, enters the double-walled section of the motor from the pipe line, which is aligned with the shafts of the unit. Inlet to the motor is at the top and bottom of the unit at the outboard end, giving access to the outer motor bearings. The fluid flows spirally and laterally around the motor, leaving at the top on the inner end, over the spacer section between the pump and motor to the pump intake. The spacer section carries no pressure, being vented to atmosphere through finely screened louvers. The inside bearings of the motor and pump are within the spacer section and between is a flexible coupling. A reservoir holding approximately 40 gal. of lubricating oil is situated in the bottom of the spacer section.

The pump, an 8-stage unit, has two sets of impellers of four stages each, arranged in opposition to equalize the end thrust and to take the high-pressure discharge from the center of the pump between the sets of impellers. The flow is from the in-

side, or motor end, of the pump through the first four stages in series, upward and out the top to the outboard end, thence through the second series of four impellers toward the center of the pump. The discharge is parallel to the axis of the pump and is carried inside the loops between stages for compactness. The loops are located below the center of the pump and the discharge pipe is carried upward at an angle to the center line of the unit.

A self-contained lubricating system is provided. A small gear-type pump with a capacity of approximately four gallons per minute is installed at the outer end of the pump shaft, and takes its suction from the lubricating oil reservoir. After leaving the small pump the oil passes through a heat exchanger located in the main fluid line between the motor and pump. Made of steel tubing, the exchanger contains 60 ft. of cooling surface. From the heat exchanger the oil is carried through a manifold to all motor and pump bearings, which are of the sleeve type, except for the thrust bearings, these being of the pivoted shoe type.

Gland leakage from the pump, should any occur, gravitates through a conductor system to a 1000-gal. tank equipped with two floats operating mercoid contactors. When the fluid level reaches the lower float the mercoid contactor starts a 5-hp., 220-volt motor direct-connected to a pump. This pump takes the gasoline from the 1000-gal. tank and discharges it into the suction line of the main pump. The second mercoid operates a relay and cuts the main pump off the line in event the small pump fails, thus preventing any loss of pipe line fluid.

Sites for each station consist of approximately one acre of ground. An electric sub-station is situated in one corner of the property. Although the pumping unit proper is located in the open, a small control room constructed of structural steel, with a corrugated iron covering, has been provided. The building is completely insulated and heated in winter by an electric car-type heater. All control equipment, including the motor-starting and control unit; all instruments, telephone, etc., are located in this building.

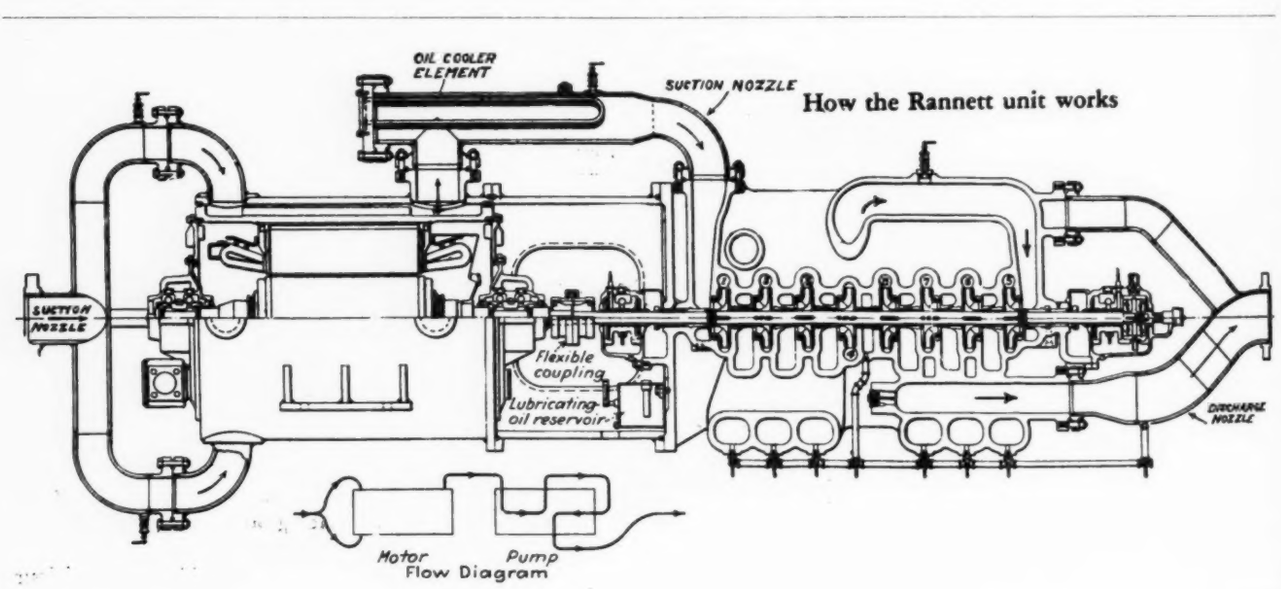
When the Rannett stations were originally installed thought was given to making them remote controlled. Switchboard connections were provided so that the necessary equipment could be added later if desired; however, to date, officials have not thought it practicable, due to the cost of installation and the fact that the required number of channels on the telephone line that would be necessary for operation cannot be spared at this time.

At Osceola and Corning, Iowa, both primary stations, installation of new units has just been completed to provide, along with the new secondary stations at Afton and Macedonia, for increased capacity on the Omaha line. The installation at Osceola is a 3-cylinder, 125-hp. Diesel at 270 r.p.m., having a 10-in. bore, 14-in. stroke and direct-connected with a 4- by 12-in. reciprocating pump with self-aligning couplings. A special housing packed with asbestos was built for the pinion shaft, for the purpose of preventing possible fire from following the shaft through the 13-in. fire-wall. At Corning a 125-hp., 3-cylinder Diesel engine at 270 r.p.m. driving a 4- by 12-in. reciprocating pump was added to the station's existing equipment, which was a unit of the same type. Previous to the new installation the Osceola plant was equipped with two 6-cylinder 330-hp. Diesels connected to 5¾- by 24-in. reciprocating pumps and one 120-hp. Diesel operating a reciprocating pump.

Construction of secondary stations has not constituted the entire expansion program of the Great Lakes Pipe Line Company. Since the original line was completed two new primary stations have been added, an electric station at Roland, Iowa, and a Diesel-powered unit at Albert Lea, Minnesota, adding to the capacity of the Des Moines-Minneapolis section of the line.

The electrically-powered station at Roland consists of two 4-stage, motor-driven centrifugal pumping units operating in series. The first unit takes suction from the incoming stream, discharging at a pressure of 400 lb. per sq. in. directly into the suction of the second unit, which in turn discharges at 800 lb. per sq. in. into the outgoing line.

The building is of brick, with all equipment, and the office, under one roof. A departure was made in the design of the Roland station in that the boiler house was eliminated as a separate building and boilers placed in the building containing the pump room, engine room and office. The boiler room is located on the engine side of the station structure with a fire-wall between and a fire-door connecting. There is no connecting door between the boiler and pump rooms, thus



Cross section of Rannett pump, showing internal details

eliminating a fire hazard. This arrangement, according to officials of the line, has greatly simplified operations and reduced the initial investment.

Telephone service was made possible by looping the main telephone line through the station, making it unnecessary to build additional line.

A number of departures from the original Great Lakes primary station design were made at Albert Lea, Minnesota. Because of a limited water supply, an enclosed heat-exchanger type of cooling system for jacket water was installed, eliminating the cooling tower, elevated water tank, one circulating pump, etc., in use at other primary stations on the line. The closed system consists of two circulating pumps, one in regular use, the other a stand-by. The pump discharges hot water from the engine outlets to the heat-exchanger, of the shell and tube type, through which the gasoline stream from the station is flowing, the gasoline acting as a cooling medium. The water then returns to the engines and from the engines passes to a vent tank, where the circulating pump takes suction and the cycle is repeated.

An air-actuated controller installed in the vent tank controls the temperature of the water. The same controller regulates a diaphragm valve in the discharge line from the pumps to the heat exchangers, permitting the water wholly or in part to be diverted around the exchangers. In this manner a fixed volume of water is constantly circulated over the engines, a highly desirable feature.

The heating system embodies the use of the fan-type heating units to replace the cast-iron sections used in the company's other primary stations.

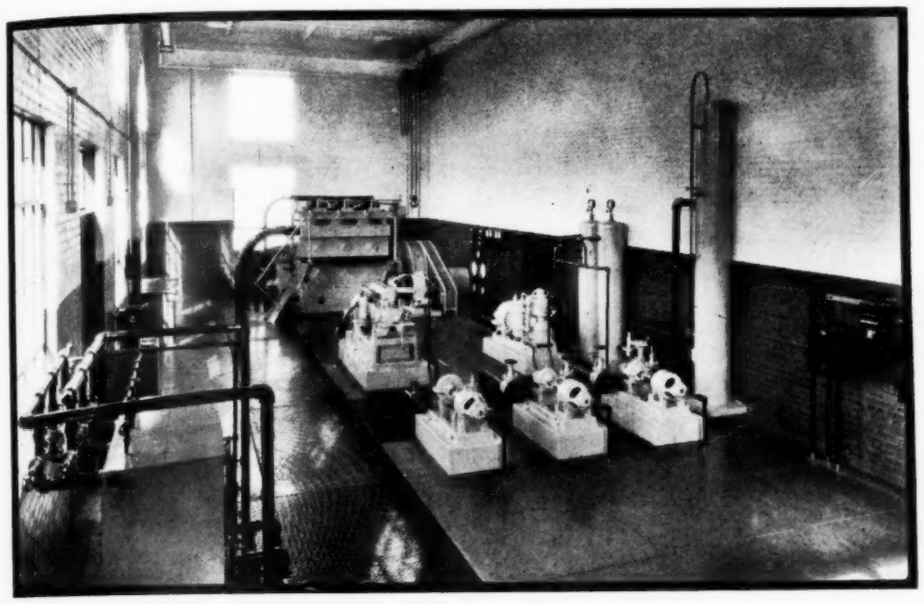
Telephone service was made by looping the main telephone line through the station from the existing line two miles away.

The Albert Lea station is Diesel-powered and equipped with duplex reciprocating plunger type pumps, identical with those in use at other primary stations on the line. As in the case of the Roland, Iowa, station, all equipment, including pumps, engines, boilers and auxiliaries are in one brick building, eliminating the boiler house.

When secondary stations were installed last year, all were of the Rannett type except at Newport, Minnesota, on the outskirts of Minneapolis, and at Pattonsburg, Missouri.

Because of inability to obtain adequate electric rates at Pattonsburg, that station is powered by two 400-hp. gasoline rail car type engines, direct-connected through speed increasers to four-stage centrifugal pumps operating in series. The closed jacket water cooling system is employed here also. All equipment is housed in one building, with a fire-wall between the pump and engine rooms. The building is of structural steel, corrugated iron construction, and is insulated throughout. Gasoline fuel for the engines is stored in a horizontal steel tank 10 ft. in diameter and 20 ft. long, adjacent to the building. Water supply is from a well located in the auxiliary room.

The Newport station is electrically powered and operates against a line pressure of 400 lb. per sq. inch. The pumping unit consists of a 125-hp. motor direct-connected to a four-stage centrifugal pump. All equipment is housed in a steel-frame, insulated building covered with corrugated iron, and heated by electric-car type heaters.

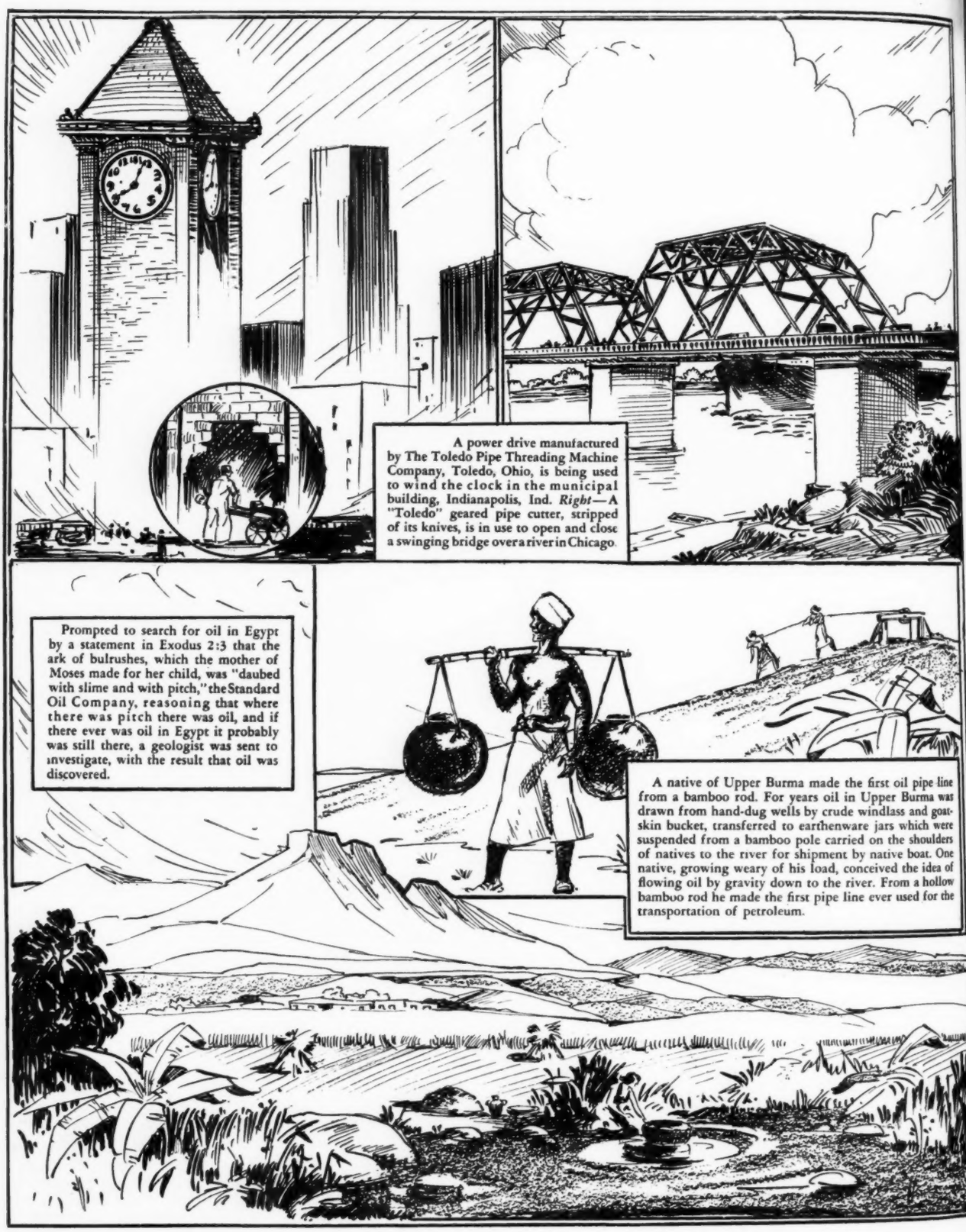


Left: Interior Albert Lea, Minn., Station, showing auxiliary equipment ordinarily installed in separate building but here erected between the two engines. The space required is made possible by opposing the pumps

Right: Roland, Iowa, Station, showing motor-driven centrifugal pumps with their control, operating in series

STRANGE... *but* TRUE

HAPPENINGS IN THE PETROLEUM INDUSTRY



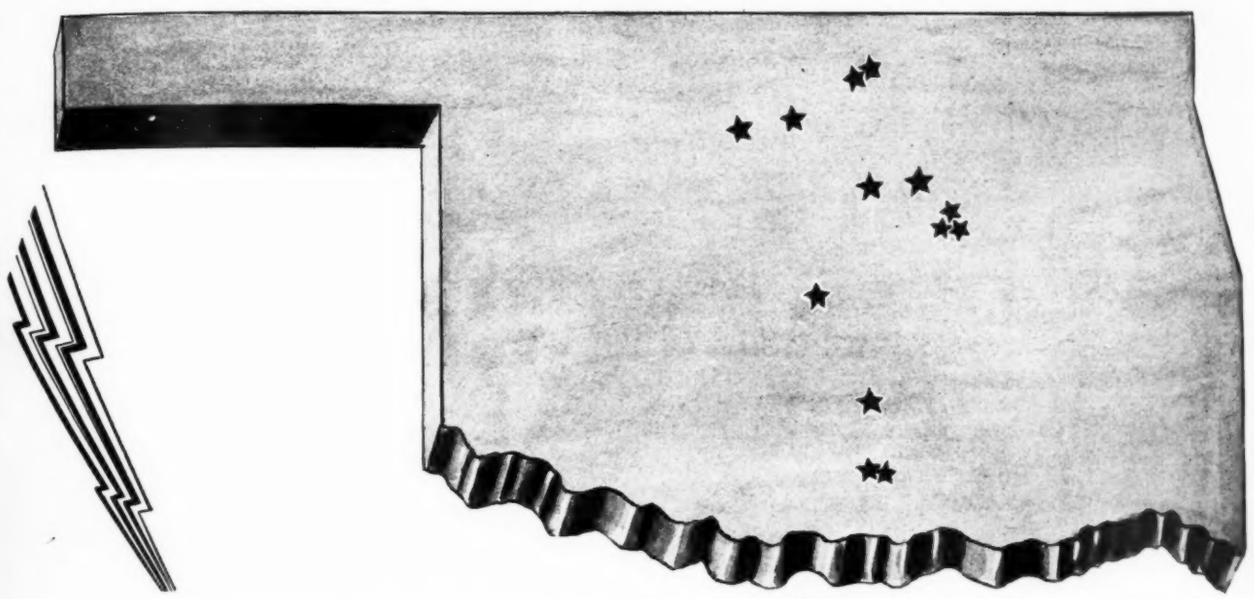
A power drive manufactured by The Toledo Pipe Threading Machine Company, Toledo, Ohio, is being used to wind the clock in the municipal building, Indianapolis, Ind. *Right*—A "Toledo" geared pipe cutter, stripped of its knives, is in use to open and close a swinging bridge over a river in Chicago.

Prompted to search for oil in Egypt by a statement in Exodus 2:3 that the ark of bulrushes, which the mother of Moses made for her child, was "daubed with slime and with pitch," the Standard Oil Company, reasoning that where there was pitch there was oil, and if there ever was oil in Egypt it probably was still there, a geologist was sent to investigate, with the result that oil was discovered.

A native of Upper Burma made the first oil pipe line from a bamboo rod. For years oil in Upper Burma was drawn from hand-dug wells by crude windlass and goat-skin bucket, transferred to earthenware jars which were suspended from a bamboo pole carried on the shoulders of natives to the river for shipment by native boat. One native, growing weary of his load, conceived the idea of flowing oil by gravity down to the river. From a hollow bamboo rod he made the first pipe line ever used for the transportation of petroleum.

Oklahoma Refineries Use *Purchased*

ELECTRIC POWER



★ Indicates refineries now being served by Oklahoma Gas and Electric Company.

Continental Oil Company	Ponca City
Empire Oil & Refg. Co.	Ponca City
Wilcox Oil & Gas Co.	Bristow
Marathon Refining Co.	Bristow
Producers Refining Co.	Bristow
Tidal Refining Co.	Drumright
Deep Rock Oil Corp.	Cushing
Garber Refining Co.	Garber
Eason Oil Co.	Enid
Black Gold Refg. Co.	Oklahoma City
Texas & Pacific Coal & Oil Co.	Wynnewood
Imperial Refining Co.	Ardmore
Cameron Refining Co.	Ardmore

Because it is more economical, more dependable, more satisfactory in every way, these Oklahoma refineries use purchased electric power.

Like other divisions of the petroleum industry, they, too, have discovered that purchased electric power saves money.

Today, Oklahoma Gas and Electric Company is serving 13 refineries in this state with a connected load of 15,000 H.P. Whether you need it for drilling, producing or pipelines we can furnish you with an unlimited supply of purchased electric power. With it there is no waste . . . you pay for only what you use.

OKLAHOMA GAS AND ELECTRIC COMPANY

Commercial Department

OKLAHOMA CITY OKLAHOMA

Interior view of typical "Purchased Power" oil line pump station using one spare pump and motor

By
G. R. PROUT
General Electric Company

Pipe Line Operation at

ELECTRIC power is now a common worker in the oil pipe line industry. Nearly all pipe line operators are familiar with the advantages to be gained by the use of electric-motor-driven pumps for gathering oil in the field and for transporting it through pipe lines to loading dock or refinery.

Electric power companies have networks of transmission lines that largely cover the territory through which pipe lines pass. Naturally, most electric pipe line stations use purchased electric power. In a few cases, where no transmission line was close to a pump station location, Diesel-engine-driven generators were installed to furnish energy to motor-driven centrifugal pumps. These installations have provided the advantages of electric drive and have been operating with a high degree of success.

There have been a large number of pump stations that have used purchased power with excellent results. While electric power costs are frequently a "bone of contention," the overall pumping costs of most of these stations have been favorable when compared with pumping costs of stations using other forms of power. This is particularly true when all the advantages afforded by electric operation are considered and evaluated.

In crude oil pumping it has been common practice to use two centrifugal pumps in each station. These pumps operate in series and each is usually driven by the simple squirrel cage induction motor. In most cases this arrangement has met the requirements of the application satisfactorily.

However, the squirrel cage motor is a constant speed machine, when the frequency of the electric service is constant. Consequently, the flexibility of the centrifugal pump driven by this type of motor is not so great as would be afforded by the use of a variable speed prime mover.

The simple mechanical construction, the ease of its operation, the insignificant maintenance cost and its other characteristics have won many friends for the squirrel cage motor. A certain amount of flexibility in capacity is afforded when this type of motor is used to drive centrifugal pumps in each station of a complete pipe line on which all pumps are centrifugals.

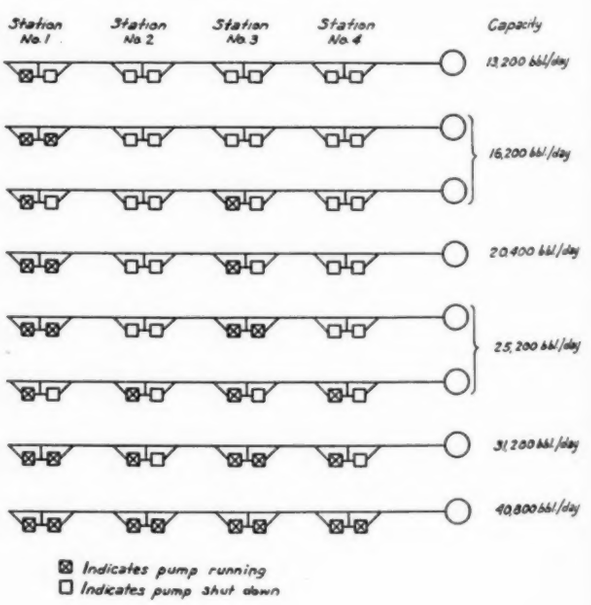
Fig. 1 shows the flexibility in capacity of a 10-in. pipe line, 160 miles long, handling crude oil, 34 degrees Baumé gravity and 100 seconds Universal Saybolt viscosity, assuming no difference in elevation along the line. This is a hypothetical case but indicates the possibilities that might be obtained by the operation of different combinations of pumps. There are several pipe lines in operation that have actually obtained the flexibility indicated by the chart under actual operating conditions.

It is true that greater flexibility in capacity would be afforded by the use of variable speed motors. Such equipment is available, but for one reason or another has been used to a very limited degree in pipe line service.

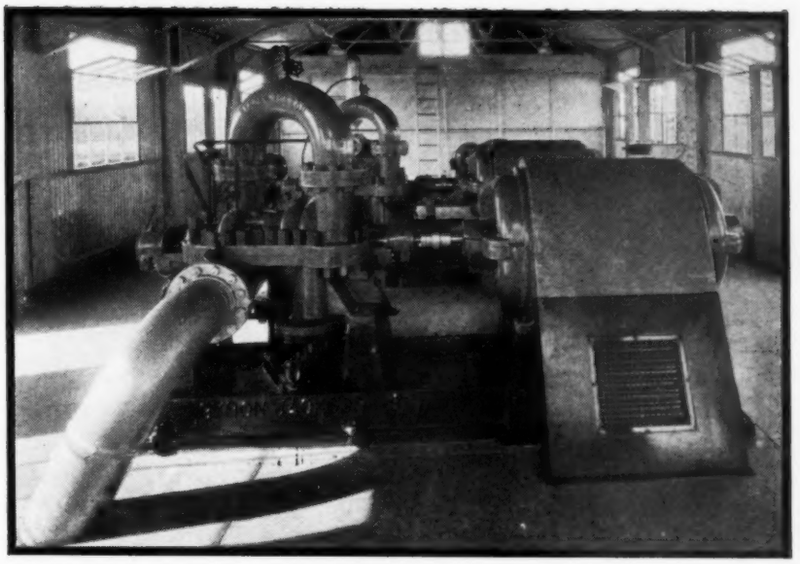
There are several ways in which variable speed characteristics would be obtained with electric apparatus using purchased power:

Fig. 1

10-in. Line 160 miles long handling crude oil of 34° Baumé gravity and 100-second Universal Saybolt viscosity



Interior view of typical "Purchased Power" oil line pump station using no spare equipment



Great Flexibility in Capacity May Be Obtained by Different Combinations of Pumps

Varying Capacities with Motor-Driven Pumps

1. Wound rotor (slip ring) induction motors.
2. Motor-generators with d.c. motors to drive pumps.
3. Scherbius control system.
4. Vacuum-tube controlled a.c. motors.

All the above, except the wound rotor induction motor, are relatively expensive when their costs are compared with that of the squirrel cage motor. Other disadvantages also appear, which seem to more than offset the advantages to be gained, on all except the wound rotor induction motor, which does have some possibilities.

The wound rotor or slip ring induction motor has been looked on with some disfavor for this type of service, because of the fact that its efficiency drops off as its speed is reduced by the connection of resistance in its rotor circuit. It is true that when this type of motor drives a constant torque load, such as a reciprocating pump, the input to the motor remains practically constant, as the speed is reduced by the insertion of resistance in the rotor circuit. This is not true, however, when the motor is driving a centrifugal pump.

The power required to drive a centrifugal pump varies with the cube of the speed, provided the pump efficiency remains constant. Tests conducted indicate that oil line centrifugal pumps do maintain their efficiency over an appreciable speed range. One such test indicates that the pump efficiency at 17 per cent speed reduction is only 1.7 per cent lower than the full speed efficiency.

The following table shows the variation in efficiency, pressure, volume and brake horsepower with change in speed of centrifugal pumps handling crude oil as obtained on actual test in a pipe line station.

Speed r. p. m.	Volume bbl. per day	*Pressure lbs. per sq. in.	Efficiency	B.hp. each of 2 pumps
3570	41,550	695	84 %	295
3270	37,480	580	83.4%	222
2960	34,616	470	82.3%	168

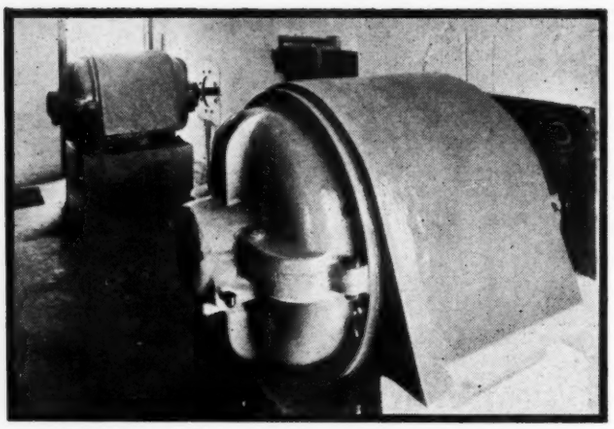
*Two pumps operating in series.

Since the pump b.hp. drops off with reduction in speed, the efficiency of the motor at reduced speed is not quite so important as the full speed efficiency. Also, as the rate of pumping in a given size pipe is reduced, the energy consumed per bbl. of oil pumped drops materially.

The amount of speed reduction required would probably not exceed 20 per cent in most cases. Referring to Fig. 1, it is seen that with two pumps running in the first and third stations and one pump in the second and fourth stations, all at full speed, the capacity is 31,200 bbl. per day. With all pumps in each station running at 80 per cent of full speed, the capacity would be 32,640 bbl. per day. Consequently, with a pumping requirement of less than 32,640 bbl. per day, one pump in the second and third stations would be shut down and the remaining pumps would be operated at full speed. If the pumping requirement was less than 31,200 bbl. per day and more than 25,000 bbl. per day, these pumps could be operated at reduced speed down to 80 per cent and the capacity would be reduced to 24,960 bbl. per day. This would provide a little greater reduction than necessary because, as shown in Fig. 1, 25,200 bbl. per day could be pumped with two pumps in the first and third stations running at full speed or with one pump in each station running at full speed. Thus by operating different combinations of pumps and by being able to reduce the speed of each 20 per cent in approximately ten steps, practically any pumping rate desired could be obtained. However, a greater speed reduction than 20 per cent can be obtained if it is required.

While the above indicated flexibility in capacities might be desirable, there are few, if any, lines operating with any type of equipment today, in which flexibility to this degree is being utilized.

The efficiency of the slip ring motors operating at reduced speeds will be less than when the motors are operating at full speed. The following table shows the power input to each



Two 350-hp. 3600-r.p.m. motors driving oil line centrifugal pumps through fire-wall in engine generator type pump station

slip ring motor, rated 350 hp., 3600 r.p.m., 2200 volts, 3-phase, 60-cycle, at various speeds.

Speed r. p. m.	Capacity bbl. per day	*Pressure lbs. per sq. in.	Pump b.hp. each of 2 pumps	Motor input hp. each of 2 pumps
3570	41,550	695	295	324
3270	37,480	580	222	270
2960	34,616	470	168	227

*Two pumps operating in series.

It is evident from the above table that the horsepower input to the motors when driving the pumps at reduced speed is materially less than when operating at full speed. With operation at a speed reduction of 17 per cent, the power input to the motors drops approximately 30 per cent.

The engine-generator, motor-driven centrifugal pump type of station affords variable speed operation. The engine speed can be reduced and as this occurs the motor speed drops in direct proportion.

Normally, 60-cycle generators and motors would be used. At 60 cycles, or full speed, the motors would operate at approximately 3570 r.p.m. At 20 per cent speed reduction the generators would operate at 48 cycles and the motor speed would be approximately 2856 r.p.m. Greater speed reduction could be obtained if desired. The generated voltage, however, should be reduced approximately in proportion to the speed. Operation at 45 cycles with generated voltage of 1800 volts would be entirely satisfactory insofar as both the generator and motor are concerned. This corresponds to a speed reduction of 25 per cent and the motor speed under this condition would be approximately 2674 r.p.m.

Following is a table showing results obtained under actual operating conditions of an engine-generator, motor-driven centrifugal pump station at 60 cycles, 55 cycles and 50 cycles, which corresponds to full speed, 91.7 per cent of full speed and 83.3 per cent of full speed, respectively:

Motor Speed	Capacity bbl. per day	*Pressure lbs. per sq. in.	Kw-hr. per bbl. pumped	Lb. of Fuel per bbl. pumped
3570	41,550	695	0.286	0.186
3270	37,480	580	0.233	0.144
2960	34,616	470	0.190	0.125

*Two pumps operating in series.

An interesting comparison of the kw-hr. used per bbl. of oil pumped appears below. This shows energy consumption at the various capacities given, (1) for the squirrel cage motor operating at reduced speeds by reduction in generator frequency, (2) for the slip ring motor operating at reduced speeds by the insertion of resistance in the rotor circuit, (3) for the squirrel cage motor driving the centrifugal pump at constant speed and the reduction in capacity obtained by throttling the pumps.

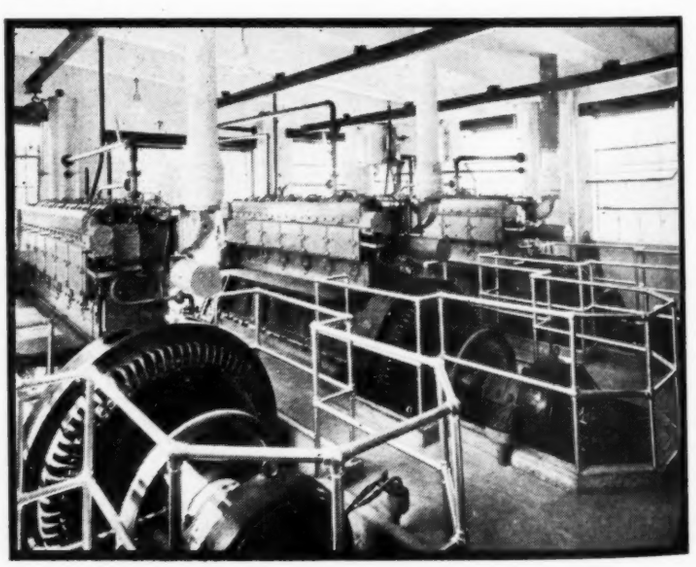
Speed r. p. m.	Capacity bbl. per day	Pressure	(1) Kw-hr. per bbl. sq. c. changed	(2) Kw-hr. per bbl. slip ring	(3) Kw-hr. per bbl. sq. c. throttled
3570	41,550	695	0.286	0.290	0.286
3270	37,480	580	0.233	0.256	0.287
2960	34,616	470	0.190	0.236	0.298

The values given for the squirrel-cage-motor-driven pumps with the pumps throttled are all with operation at 3570 r.p.m., but with the capacities shown and the pressure in the line throttled to the above approximate values. These values as well as those for the squirrel cage motors operating at reduced speeds are from actual tests. The values for the slip ring motors are calculated but should be approximately correct.

The question of fire hazard with respect to the slip ring motor naturally arises. However, this type of motor can be furnished with the slip rings enclosed in a so-called "explosion proof" casing at a nominal increase in price over the standard construction. When such a motor is used, the hazard from sparking is no greater than it would be with the standard squirrel cage motor.

So far as we know, there have been no serious fires in any electric oil pipe line station using purchased power or engine generators, the cause of which was attributed to the electrical equipment. This would indicate that electrical equipment being used is reasonably safe when considered from the standpoint of fire hazard.

It is perhaps unfortunate that there are no a.c. adjustable speed motors available in the horsepower and speed ratings required by oil line pumps, that are as simple mechanically and as efficient electrically as the squirrel cage motor. At the present time the slip ring motor seems to be the best available for the application requiring varying speed when purchased power is used and it does a creditable job. The operator must balance the advantages to be gained by its use, against the disadvantages of a nominal increase in first cost and a somewhat greater power consumption per bbl. of oil pumped.



Engine-generator room of pipe line pump station, capacity 42,000 bbl. per day at 695 lb. pressure. Power generated to drive two 350-r.p.m. motor-driven centrifugal pumps.

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

We understand that druggists are so busy handling liquor that they're thinking about giving up their sandwich business.

✓ ✓ ✓

Joe: Did you get your hair cut?

Jim: No, I just washed it and it shrank.—*Annapolis Log.*

✓ ✓ ✓

Two students were uncertainly flivvering their way home.

"Bill," says Henry, "I wan'cha to be very careful. Firs' thing ya' know you'll have us in a ditch."

"Me?" said Bill, astonished, "why, I thought you was driving."

—*Arizona Kitty-Kat.*

✓ ✓ ✓

Druggist: How's your wife today?

Customer: Oh, she can't complain.

Druggist: I didn't know she was as ill as that.—*Illinois Siren.*

✓ ✓ ✓

"We've got to give him something that'll backfire on his nose and make him sneeze," said Dr. Auspice, the veterinarian called to treat the lumberjack. "Mix up a pint of linseed oil, a half cup of salt brine, some castor oil and red pepper. Let me know in the mornin' how he feels."

The next morning the foreman called the horse doctor on the phone.

"Olie sneezed last night," he said.

"That's fine," said Dr. Auspice. "How many times?"

"Three," snorted the foreman. "Once before and twice after he died."

—*Louis Allis Messenger.*

✓ ✓ ✓

A certain country minister posted this notice on the church door: "Brother Smith departed for Heaven at 4:30 A. M."

The next day he found written below: "Heaven, 9:00 A. M., Smith not in yet. Great anxiety."

✓ ✓ ✓

A guy isn't necessarily expecting a blessed event just because he buys some baby clothes.

Three blood transfusions were necessary to save a lady patient's life at a local hospital not so long ago, and a brawny young Scotchman offered his blood. The patient gave him $50 for the first pint, $25 for the second pint —but the third time she had so much Scotch blood in her she only thanked him.

✓ ✓ ✓

A photographer was taking a picture of a father and his college-boy son. The photographer suggested that the boy stand with hand on his father's shoulder.

"It would be more appropriate," said the long-suffering parent, "if he stood with his hand in my pocket."

—*Louis Allis Messenger.*

✓ ✓ ✓

Traveling Man: Waitress, all I want for breakfast this morning is two soft-boiled eggs, a cup of coffee and a few kind words.

The waitress returned with his order, whereupon the traveling man said: "Well, here are the eggs and the coffee, but where are the kind words?"

Waitress: Don't eat them eggs.

✓ ✓ ✓

A Prize Play

Author: This play is about rheumatism, flat feet and halitosis.

Producer: Good grief, what's the big idea?

Author: Well, didn't you tell me to put everything I've got into it?

✓ ✓ ✓

Medico: You have high blood pressure.

Patient: That's funny. The doctor across the street said it was low.

Medico: Naturally. He doesn't raise women's blood pressure like I do!

✓ ✓ ✓

Since the new stenographer joined the NRA she won't take anything down after 4:30.

—*Bridgeport Bulletin.*

✓ ✓ ✓

"What color are violets?"

"She doesn't wear any."

—*U. S. C. Wampus.*

A smart girl is one who can make her complexion taste as good as it looks.—*V. P. I. Skipper.*

✓ ✓ ✓

"My grandfather had a terrible time keeping his scalp in a healthy condition."

"Oh, was he troubled by dandruff?"

"No, he was troubled by Indians."

✓ ✓ ✓

A golddigger asks for a fur coat because she hates exposure—a sugar papa grants her wish for the same reason.

✓ ✓ ✓

One Siamese Twin to Another: You must have had a swell time last night. I look like a wreck today.

—*William's Purple Cow.*

✓ ✓ ✓

"What will it cost me to have my car fixed?"

"What's the matter with it?"

"I don't know."

"Fifty-two dollars and fifty cents."

—*Yale Record.*

✓ ✓ ✓

"Do you smoke cigarettes?"

"Sure! what do *you* do with them?"

—*Northwestern Purple Parrot.*

✓ ✓ ✓

William: How did you break your leg?

Bill: I threw a cigarette in a man hole and stepped on it.

—*Colgate Banter.*

✓ ✓ ✓

Advertisement in Reading (Mass.) *Chronicle:* Wanted—Small apartment by couple with no children until May 1.—*Alabama Rammer-Jammer.*

✓ ✓ ✓

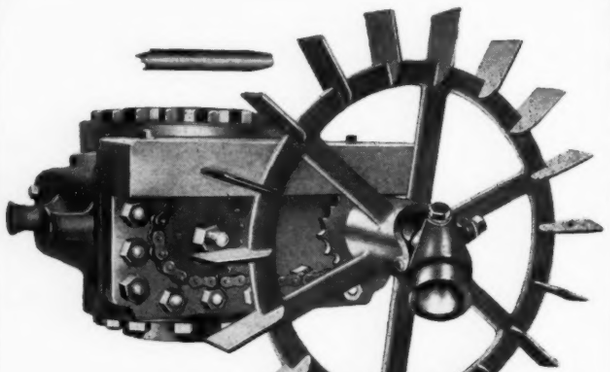
"You ought to feel honored, highly honored, young man. Do you know that today I have refused to see seven insurance men?"

"I know," said the agent. "I'm them!"

✓ ✓ ✓

First Aid Instructor: What would you do if a man was pale, sweating profusely, unconscious, bleeding from the mouth, eyes and ears, and had a fractured skull and arms?

Student: I'd bury him.



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THE HANDBOOK OF APPLIED MATHEMATICS. By Martin E. Jansson. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York City. 800 pages, 150 tables, 375 illustrations. Price $6.00. A special pre-publication price of $4.95 is being made until the second printing is ready.

This book starts with a complete review of all the mathematics you should know to make every type of calculation. Then it takes up every trade, and gives full explanations of practical methods, plus easily-worked formulas for applying those methods to your own problems. Thousands of practical examples show just how to calculate every figure. It has been thoroughly indexed so that you may find instantly every needed fact.

* * *

HANDBOOK OF CHEMISTRY AND PHYSICS, 18th Edition. Charles D. Hodgman, M.S. Editor-in-Chief. Chemical Rubber Publishing Co., Cleveland, Ohio. 1818 pages. Price, $6.00.

The eighteenth edition of the Handbook of Chemistry and Physics represents a 20-year accumulation of essential data for the busy scientist and engineer. This edition contains 220 pages of mathematical tables and formulae; 800 pages of chemical tables, including physical constants of 4000 organic compounds and physical constants of 4000 inorganic and metal-organic compounds; 44 pages of properties of matter; 135 pages of heat; 54 pages on sound, electricity and magnetism; 204 pages on light, 134 pages on measures and units, and many useful tables, charts, etc., of interest to all workers in the sciences.

* * *

PROCEEDINGS OF THE WORLD PETROLEUM CONGRESS. Joint Editors: A. E. Dunstan, D.Sc., F. I. C., F. C. S., M.Inst. P.T.; and George Sell, M. Inst. P. T. Published by World Petroleum Congress, Aldine House, Bedford Street, London, W. C. 2, England. Two vol. Prices: 3 pounds, 10 shillings for members of the Congress, and 3 pounds, 13 shillings, 6 pence for others, for both volumes.

These two volumes contain a record of the complete proceedings of the World Petroleum Congress held in London in July, 1933. Volume 1 is devoted to geology and production, while Volume 2 is given over to refining, chemistry and testing. Papers delivered before the Congress are reproduced in full and minutes of the meetings recorded.

The general topics discussed in the Production Section, under the head of Drilling are: "Pressure Drilling," "Drilling Mud," "Cementing," "Deviation" and "Equipment," and under the head of Production, "Analytical Considerations of Reservoir Conditions and Their Relationship to Production Practice," "Collection and Application of Data From Bottom-Hole Samples," "Relationship between Reservoir Conditions and the Most Effective Rate of Production for Wells," "Modern Developments in the Raising of Oil," and "Treatment of Crude Oil Emulsions."

Some of the most noteworthy papers included in this volume are "The Drilling and Control of High-Pressure Wells," by M. C. Seamark; "Modern Development in Control of Pressure, Heaving Shales, etc.," by C. A. Moon, "The Functions of Mud Fluids used in Rotary Drilling," by W. E. V. Abraham, "Oil Well Cementing in Deep Wells," by C. P. Parsons.

In Volume 2, Refining, Chemical and Testing Section, some of the principal topics are "The Refining of Cracked Gasoline and the Use of Inhibitors for Gum Prevention," "Determination of Gum in Gasoline," "Knock-Rating: Mo-

tor Gasoline and Aviation Gasoline," "Hydrogenation" and "Extraction Processes for the Refining of Oil." Especially interesting among the papers are "Sulphuric Acid Treatment of Cracked Distillates," by Jacque C. Morrell and Gustav Egloff; "Refining Cracked Gasoline by the Gray Process," by M. R. Mandelbaum; "The Possibility of the Determination of Potential Gum in Gasoline by Ultra-Violet Rays," by Dr. M. Freund; "Effect of Engine Design on Octane Number Ratings," by William H. Hubner and George B. Murphy, and "Comparison of Cracking and Hydrogenation as Methods of Producing Gasoline," by R. T. Haslam, R. P. Russell and W. C. Asbury.

As an added feature, each volume contains the papers of Sir John Cadman on "Science in the Petroleum Industry" and J. B. Aug. Kessler on "Rationalization of the World Oil Industry."

For the convenience of those in the United States who wish to purchase the proceedings, orders will be accepted by W. J. Mallory, 8-10 Bridge Street, New York City.

George H. Luck Dies

Friends of George H. Luck, formerly Louisiana representative for Mission Manufacturing Company, Houston, Texas, were shocked to learn of his recent death in Lake Charles, Louisiana. He was 54 years of age.

Murray Branch at Fairfax, Oklahoma

The Murray Tool and Supply Company, Tulsa, Okla., announces the opening of a branch at Fairfax, Okla., to serve the Naval Reserve and South Burbank pools. A complete line of supplies is carried in stock and the company also has a machine, blacksmith and forge shop in connection.

New Union Wire Rope Warehouse at Monahans, Texas

The men shown above are: Left to right—C. K. McKendry, Warehouseman; Jack Leidecker, Leidecker Drilling and Production Co.; Jack Morrisey, G. J. Donnelly Drilling Co.; Jack Prigg, Driller for Gulf Production Co., and H. R. Cutlip, Texas representative for Union Wire Rope Corporation.

The Union Wire Rope Corporation of Tulsa, Okla., announces the recent opening of a warehouse at Monahans, Texas, with a complete stock of Union Wire Lines for the oil industry. This new warehouse is located along the famous Bankhead highway and is kept open 24 hours a day.

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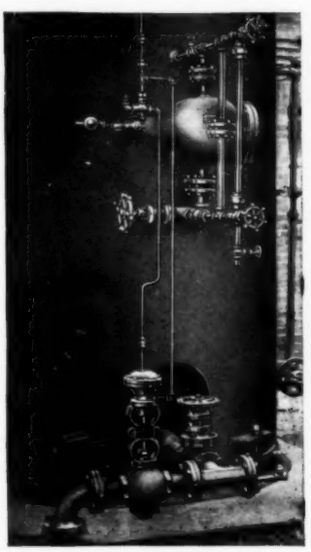

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Title.....

(To avoid delay, please do not fail to state your title.)

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City..... State.....

Country.....

Appointed District Manager

Linn K. Park has been appointed district manager for The Buda Company, of Harvey, Illinois, to handle the distribution and sales of Buda gas-gasoline and M. A. N. Diesel engines, for oil field applications, covering Texas, Arkansas, Louisiana and New Mexico.

LINN K. PARK

Mr. Park is well known in the supply and manufacturing fraternities, having organized the Portable Rig Company of Houston in 1924.

The Buda Company is installing stocks of engines and repair parts, together with service facilities, at Kilgore in the East Texas field, and also at Houston. Mr. Parks' headquarters are in the Esperson Building, Houston.

Opens Dallas Office

The Refinery Supply Company of Tulsa, Okla., opened a branch office in the Santa Fe Building, Dallas, Texas, on March 15, according to an announcement by W. A. Schleuter, president. D. R. Davis, recently with the Industrial Scientific Supply Company, Houston, Texas, and prior to that for many years with the Taylor Instrument Companies, is in charge. The office will serve the states of Texas and Louisiana.

Opens New Sales Office

The Texas Steel Company of Fort Worth, Texas, has opened a sales office and warehouse in Houston to serve the Gulf Coast area. Charles Graham, of the Fort Worth office, has been placed in charge of sales in that territory. H. M. Keeling recently was appointed sales representative for the North Texas district with headquarters in Fort Worth.

"Caterpillar" Holds District Meetings

A series of 14 territorial meetings, which will be attended by every dealer east of the Rocky Mountains and most of their salesmen, servicemen and partsmen, has been scheduled by the Caterpillar Tractor Company, Peoria, Illinois. The first of the series was held at the factory April 3 and the meetings will extend through May 21.

The "Caterpillar Twenty-two," the company's latest addition to its tractor line, as well as the three Diesel models, are being featured in the programs. The party making the trip is comprised of H. P. Mee, vice president in charge of sales; E. R. Gavin, eastern division sales manager; L. J. Fletcher, general supervisor of agricultural sales; and J. F. Goss, service department.

Ed Ziegler New Franklin Valveless President

Announcement has been issued that Ed P. Ziegler, who for many years has been general sales manager of Franklin Valveless Engine Co., Franklin, Pa., has been elevated to the presidency of the organization, succeeding C. H. Sheasley, deceased. E. A. Crossen has been made vice president, and Cliff G. Neely continues as secretary-treasurer.

Moves Houston Offices

Houston offices of Lee C. Moore, Inc., have been moved from M. & M. Building to 3229 Navigation Boulevard, where stocks will be carried. George I. Lynch is manager.

All Plans Completed for Tulsa Oil Show

WITH exhibit space almost completely sold, the eighth International Petroleum Exposition promises to be one of the largest and most successful ever held. Four hundred and six contracts have been signed for exhibit space and many of these represent exhibits for several different firms, William B. Way, general manager, announces.

One feature of the show will be a meeting of dealers and jobbers with refiners to discuss common problems. Two sessions will be held, May 18 and 19.

The following associations will hold meetings during the show: American Association of Petroleum Geologists, American Society of Mechanical Engineers, Mid-Continent Oil & Gas Association, Mid-Continent Petroleum Safety Council, Purchasing Agents of the Southwest and Mid-Continent, and the Independent Petroleum Association of America.

Indications are that a large foreign delegation will be on hand. Official delegates will be sent by England, Canada, Germany, Mexico, Portugal, Russia, Ecuador, Honduras, and, in addition, many foreign firms plan to send representatives. If the record of the last show is reached, 21 foreign nations will be represented.

Many features of the show will not only be entertaining, but instructive as well. A demonstration will be given of how one of the most dangerous hazards of the oil field, the oil and gas well fire, is put out by use of nitroglycerine. Many executives have employed fire fighting experts to extinguish wells, but few have witnessed how the operation is done. The exposition has obtained the services of M. M. Kinley, who has put out more than 60 oil well fires, including the famous Roumanian well, to give the demonstration. Actual oil field conditions will be portrayed.

The exposition also will offer a pageant of oil, portraying the history of oil from early Biblical times to the present. The pageant is being offered to commemorate the 75th anniversary of the oil industry in the United States.

Since many oil men are followers of the turf, a horse show will be held, arranged by Fred Phillips, one of the Mid-Continent's leading oil men. Prizes amounting to $3,000, in addition to silver trophies, will be awarded.

A collection of special exhibits, selected by the scientific and technical committee, will show the latest improved scientific apparatus. The photo-electric cell, commonly known as the electric eye, and its various adaptations to the oil industry, the latest types of viscosimeter, flash and fire testers, consistometers, hydrometers, high vacuum pumps, power provers for checking efficiency of gasoline, miles per gallon and preventable losses will be among these exhibits.

Dallas Making Elaborate Plans for A. P. I. Convention

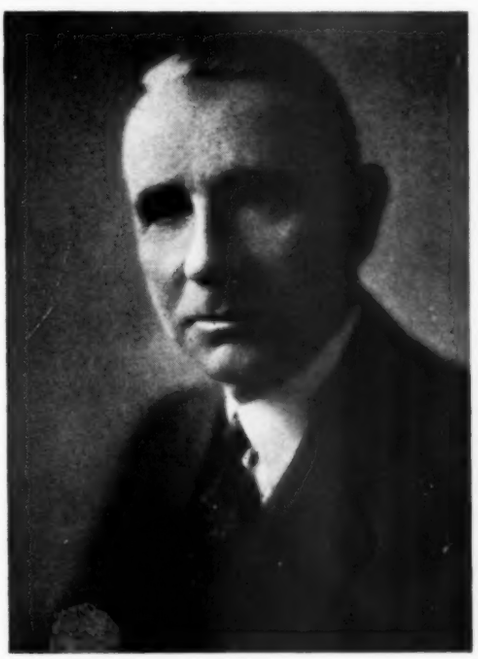
With the appointment of convention committees by Captain J. F. Lucey, general chairman, preparations for entertaining the fifteenth annual meeting of the American Petroleum Institute in Dallas, Texas, November 12-15, are progressing rapidly. Drawing freely from a background of broad accomplishment, Captain Lucey, head of the Lucey Petroleum Company, expects to care for A.P.I. delegates to the Dallas convention in such a way as to make their visit a memorable event. It was this same Captain Lucey who fed 6,000,000 Belgians early in the World War with such success as to win world-wide praise.

Under the leadership of R. B. Whitehead, chairman, the A.P.I. hotel reservation committee already has established offices in 1311 Magnolia Building, Dallas, and is prepared to answer all questions concerning local accommodations. With a total guest capacity of 20,000, Dallas hotels are prepared to care for the largest convention in the history of the A.P.I. and the comfort of guests is assured. Of the 85 directors of the A.P.I., 80 already have made reservations for the convention and total rooms reserved to date number 1200.

By taking reservations so far in advance of the convention dates the Dallas hotel committee expects to inaugurate an innovation in the reception of convention guests. It is planned to assign all hotel rooms in advance so when convention visitors arrive in Dallas by railroad, airplane, bus or automobile their hotel room key will be ready for them, and they will not be required to register. Baggage will be gathered at the terminals and should be in hotel rooms by the time convention delegates arrive there.

Chairmen of the convention committees will be glad to hear from oil men planning to attend and will give any information requested. Following are the committees appointed by Captain Lucey:

Legal: Judge W. H. Francis, Magnolia Petroleum Company; *Hotel Reservation*: R. B. Whitehead, Atlantic Oil Producing Company; *Refinery*: F. W. Burford, East Texas Refining Company; *Geologists*: Leon J. Pepperburg, Dallas, Texas; *Land, Lease and Scouts*: J. H. Langston, Sun Oil Co.; *Drilling Contractors*: M. J. Delaney, Dallas, Texas; *Equipment and Supply*: F. M. Mayer, Continental Supply Company; *Finance*: Nathan Adams, First National Bank in Dallas; *Transportation*: H. S. Moss, Railroad and Auto Division; Carl C. Joys, A. O. Smith Corporation, Airplane Division; *Communications*: C. L. Stewart, Southwestern Bell Telephone Company; *Entertainment*: John J. Pew, Sun Oil Co., and entire Dallas Wildcat Committee; *Accountants*: L. S. Sinclair, Magnolia Petroleum Company; *Publicity*: Clarence Morris, *The Petroleum Engineer; Refined Products Sales*: Frank Triplett, Gulf Refining Co.; *Crude Oil Marketing and Transport*: D. A. Little, Magnolia Petroleum Company; *Royalty Owners*: Ballard Burgher, Dallas, Texas; *Production and Engineering*: Blaine Johnston, Simms Oil Company.



Capt. J. F. LUCEY

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Room rates start at $2.50.

Equipment Furnished for Use in Conducting Fluid Flow Research Described in this Issue, Beginning on Page 29

1. Heat exchanger
   Tulsa Boiler & Machinery Co., Tulsa, Okla.
2. Two tanks (one mounted on top)
   —National Tank Co., Tulsa, Okla.
3. Two recording, multiplying potentiometers
   —Brown Instrument Co., Philadelphia, Pa.
4. Two thermocouples
   —Brown Instrument Co., Philadelphia, Pa.
5. Two recording pressure gauges
   —Brown Instrument Co., Philadelphia, Pa.
6. 200 charts
   —Brown Instrument Co., Philadelphia, Pa.
7. Two quick-closing valves
   —Fisher Governor Co., Marshalltown, Ia.
8. One 5-in. rotary pump
   —Viking Pump Co., Cedar Falls, Ia.
9. One 40-hp. motor and starter
   —Allis Chalmers Co., Milwaukee, Wis.
10. One rotary pump
    —Northern Pump Co., Minneapolis, Minn.
11. One 15-hp. motor
    —General Electric Co., Schenectady, N. Y.
12. Recording temperature regulator
    —Taylor Instrument Co., Rochester, N. Y.
13. One 4-in. Venturi meter tube
    —Builders Iron Foundry, Providence, R. I.
14. One 2-in Venturi meter tube
    —Builders Iron Foundry, Providence, R. I.
15. One 4-in Venturi tube, style NSL
    —Builders Iron Foundry, Providence, R. I.
16. One 2-in. Venturi tube, style NSL
    —Builders Iron Foundry, Providence, R. I.
17. Three transformers
    —Empire Companies, Bartlesville, Okla.
18. Two float valve gauges
    —Rochester Mfg. Co., Rochester, N. Y.
19. One flow meter
    —Midwest Equitable Meter Co., Tulsa, Okla.
20. Three 6-in. flange lubricated plug valves
    —Walworth Company, Boston, Mass.
21. One recording pressure gauge
    —Bristol Co., Waterbury, Conn.
22. Two indicating pressure gauges
    —Bristol Co., Waterbury, Conn.
23. 6-in., 4-in., 3-in. plug valves
    —Merco-Nordstrom Co., San Francisco, Calif.
24. 4-in. Robinson orifice fitting
    —Robinson Orifice Fitting Co., Los Angeles, Calif.
25. Steam trap
    —Armstrong Machine Works, Three Rivers, Mich.
26. Two relief valves
    —Crane Co., Chicago, Ill.
27. Sixteen orifice plates and flanges
    —Metric Metal Works, Erie, Pa.
28. Sixteen orifice plates and flanges
    —Foxboro Co., Foxboro, Mass.
29. Four straightening vanes
    —Foxboro Co., Foxboro, Mass.
30. Eight flow nozzles
    —Foxboro Co., Foxboro, Mass.
31. Eight flow nozzles
    —Bailey Meter Co., Cleveland, O.
32. 4-in., 3-in., 2-in., 1½-in. plug valves
    —Timken-Michigan Co., Detroit, Mich.
33. Twelve ½-in. globe valves
    —The Lunkenheimer Co., Cincinnati, O.
34. Fifteen ½-in. globe valves
    —Reading-Pratt & Cady Co., Bridgeport, Conn.
35. Fifteen ½-in. globe valves
    —Wm. Powell Co., Cincinnati, O.
36. Fifteen ½-in. globe valves
    —Jarecki Mfg. Co., St. Louis, Mo.
37. Insulation material for set-up
    —Johns-Manville Co., New York City

TESTING APPARATUS

The apparatus used on these tests was as follows:

1 Stop clock, by Wm. Pye Co.
1 Imperial stop watch.
3 Thermometers.
12 Separating chambers.
11 Manometers, by Mariam.
1 Scale, by Fairbanks Morse & Co.
1 Scale, by Howe Scale Co.
1 Weighing tank, by H. Mueller Mfg. Co.
1 Weighing tank.
1 Temperature recording gauge, by Taylor Instrument Co.
20 Bbl. of cylinder stock oil, by Continental Oil Co.
30 Bbl. of cylinder stock oil, by Empire Refining Co.

D. D. Wertzberger Dies in Crash

D. D. Wertzberger, president and owner of the Wertzberber Derrick Co., Tulsa, Okla., prominent in Mid-Continent oil circles for the last 35 years, was killed April 3 in an automobile accident near Edmond, Oklahoma.

Returning from a business trip to Oklahoma City, his car ran off the edge of the pavement into loose gravel, skidded

D. D. WERTZBERGER

and overturned. The accident was witnessed by a group of oil field workers who rushed to his assistance. Wertzberger was conscious and requested to be taken to a Guthrie hospital where he died 45 minutes later.

The deceased was born at Decatur, Ind., 52 years ago. His first connection with the oil industry was with the Elwood Supply Company in 1900. Two years later he went with the Oil Well Supply Company and remained with that organization until he formed a partnership with Col. C. E. Suppes and entered the oil derrick manufacturing business 25 years ago.

Surviving are his widow, Mrs. Leone Wertzberger; two daughters, Mrs. H. G. Marqua and Miss Florice Wertzberger, both of Tulsa; and a son, Robert J., also of Tulsa.

American Meter Co. in New Offices

Announcement has been made of a change in address of the New York office of American Meter Company. That organization, manufacturers of instruments used in the measurement and control of gas, oil, steam, air and liquids, is now located in Room 2925 Lincoln Building, 60 East 42nd Street. Formerly American Meter Company headquarters were maintained at 105 West 40th Street.

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Handles are forged of steel that gives both stiffness and spring. Jaws are drop forged, hardened, tempered and tested for toughness. Chains have known strength, for they are proof tested to 2/3 catalog strength (3,600 to 40,000 lbs.). There is an extra value in these tongs that cuts tool cost.

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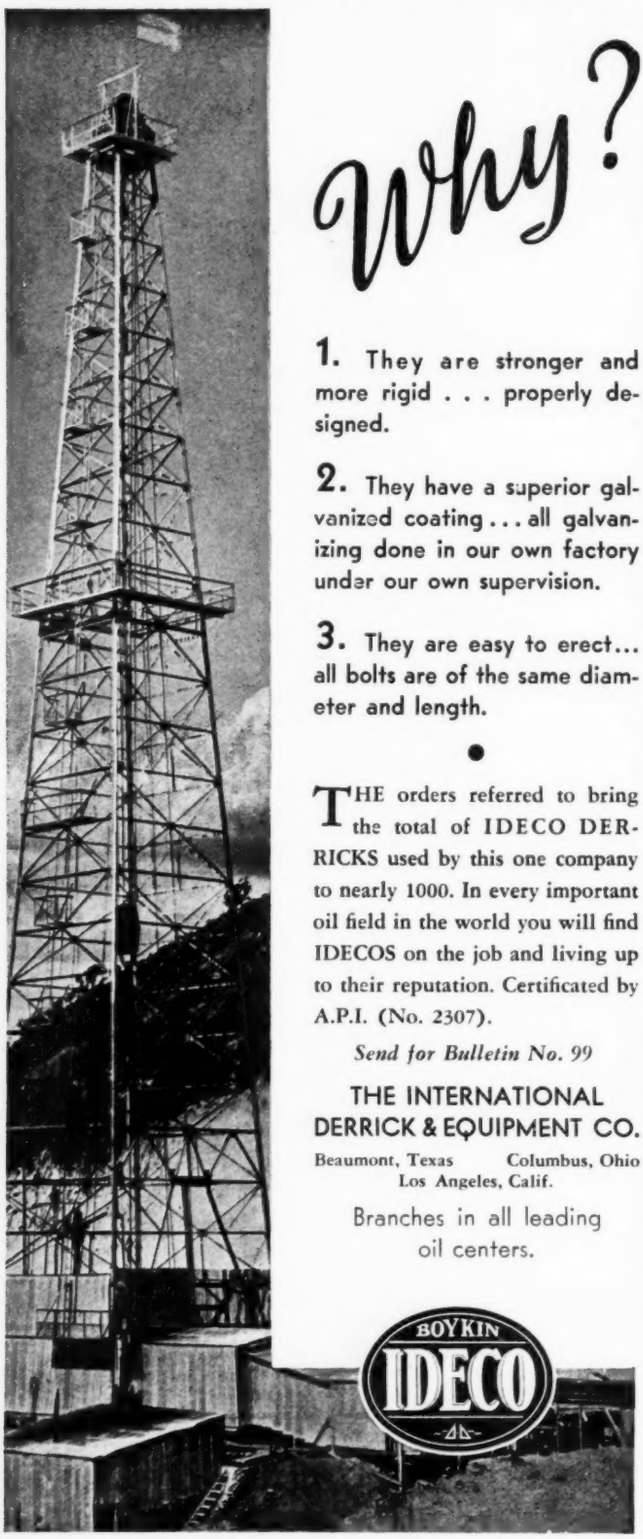

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